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A R G O N N E   N A T I O N A L   L A B O R A T O R Y

IDAHO DIVISION

REPORT OF EBR-II OPERATIONS

April 1, 1968 through June 30, 1968

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IDAHO FALLS, IDAHO

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M. Novick, Director, Idaho Division

Contributors

B. C. Cerutti	J. K. Leman
D. W. Cissel	K. J. Moriarty
L. P. Cooper	R. Neidner
G. E. Deegan	W. H. Olson
H. Hurst	R. N. Smith
F. S. Kirn	W. R. Wallin

Report Coordinated by

W. R. Wallin

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I. Operations

A. Summary

The reactor was operated during this quarter to complete Runs 27D through 27I and Runs 28A, 28B, and 28C. Run 29A was in progress at the end of the quarter. The large number of short runs was required to identify the subassembly releasing fission-product rare gases. The experimental subassemblies were removed in groups until the fission-product level in the cover gas showed no further increases; then the most suspect of these subassemblies (X028) was returned to the core and an increase in activity occurred. The defective subassembly was thus identified. Run 29A was the first step in returning the natural-uranium inner blanket to the reactor. Integrated power in this quarter was 1928 MWdt.

Fission-product rare-gas releases occurred during reactor operation on April 6, 12, 16, 19, and May 6. Releases were also observed after a primary-pump flow reduction, a pump shutdown immediately following reactor shutdown, and during the initial removal of experiment X028 from the core. Increases in cover-gas activity ranged from a factor of 2 to a factor of 140. The reactor was shut down immediately after each release.

The power reactivity decrement was measured early in each run and found to vary between 41.3 and 47.5 Ih for the power increase from 0 to 45 MW. A reduced-flow constant-ΔT experiment was performed during Run 28A.

Reactor kinetics experiments were conducted in Runs 28A, 28B, and 28C. The experiments included rod-drop tests from various power levels, and operation at sustained power without manual adjustment of controls at various power levels and flows. These tests were aimed at determining the effects of ceramic-fueled experimental subassemblies on the feedback function, and at determining whether correlations of various reactor conditions with power-level variations could be defined.

An experimental high-worth control rod containing a natural boron follower was inserted into the No. 5 control-rod position. Its total calibrated reactivity worth was found to be 178 Ih, a gain of approximately 40 Ih over a standard control-rod subassembly in that position. The experimental control-rod subassembly was replaced with a standard control-rod subassembly after calibration was completed.

Returning the reactor to a depleted-uranium inner blanket in place of stainless steel was scheduled to be accomplished in three steps. Step one, Run 29A, consisted of establishing a reference loading with stainless steel subassemblies in Rows 7 and 8. For Run 29B, Row-7 stainless steel subassemblies were to be replaced by uranium subassemblies, and for Run 29C, the same was to be done in Row 8.

Prior to Run 29A the oscillator rod was removed and a standard control rod was installed in its place. Rotating-plug seals were cleaned.

B. Chronology of Principal Events

DATE	EVENT
4/1/68	Reactor power at 45 MW for Run 27D to try to identify a leaking experimental subassembly. Run 27D scheduled to continue for a Run-27 total of 750 MWd or until a fission gas release is observed.
4/2/68	Primary purification system shut down and frozen because of a suspected leak in primary plugging loop.
4/4/68	Leak found in the bellows on the throttle valve in the primary plugging loop.
4/6/68	Reactor power 45 MW. High-count-rate alarm received from the charged wire monitor. Reactor shut down. Large increases in Xe-133 and Xe-135 activity and slight increase in reactor-building air activity noted. Subassemblies B-372, B-373, X012, X015, X017, and C-2138 removed. Subassemblies C-2070, C-2060, C-2066, C-2065, A-739, and A-733 installed.
4/7/68	Reactor made critical, then shut down to make reactivity adjustment. Reactor started up for Run 27E and control rods calibrated.
4/8/68	Power coefficient measurements initiated from 50 kW to 45 MW in 5-MW increments. Reactor scram caused by control malfunction in primary pump No. 2. Reactor restarted.
4/9/68	Reactor scram from 10 MW, possibly caused by low reference voltage in clutch of primary pump No. 2. Special recorders installed on primary pumps Nos. 1 and 2 to check for cause of scrams. Reactor restarted and power increased.
4/10/68	Reactor power 45 MW. Power reactivity decrement (PRD) measured from 50 kW to 45 MW. Primary purification test in progress. Bellows leak repaired in the primary-plugging-loop throttle valve.
4/11/68	Reactor scram from 45 MW caused by "Reactor Inlet Coolant Core Inlet Pressure 1 or 2 Rate of Change". Replaced a bad tube in the MV/I circuit. Gas samples taken with primary pumps at 100% flow and reactor shut down indicated a probable fission gas release.
4/12/68	Unrestricted fuel handling started. Experimental subassembly X034 installed in core position 2-F-1. Heatup of primary purification system in progress.

B. Chronology of Principal Events (continued)

DATE	EVENT
4/13/68	Unrestricted fuel handling completed. Subassemblies X019, X020, X027, X032, and A-813 removed and replaced with B-371, B-373, C-2009, A-789, and X035. Reactor started up and control-rod calibrations begun. Reactor scram caused by low flow at reactor coolant outlet.
4/14/68	Reactor restarted. Power coefficient data obtained from 50 kW to 45 MW. Primary purification system in service.
4/15/68	Reactor scram caused by shorted instrument slide wire. Primary flow reduced and slight fission-gas release indicated. Reactor kept shut down for fuel handling. Subassembly X010 removed and replaced with subassembly A-813. XG02 also removed.
4/17/68	Subassembly A-748 installed in place of XG02. Subassemblies XG03, XG04, X033, and X031 removed and replaced by A-735, A-799, C-2062, and B-385. Reactor started up and operated at 50 kW. Reactor scrammed by voltage dip on incoming power lines.
4/18/68	Reactor restarted and PRD measured for Run 27G. Flow established in primary purification bypass; cold trap being heated.
4/19/68	Reactor power 45 MW. Primary purification system shut down because of low vacuum in surge tank. Slow increase seen on the FGM. Gas sample taken and the reactor shut down on confirmation of a large gas release. Reactor building temporarily on limited access.
4/20/68	Primary purification system still shut down. Subassemblies B-363, B-374, B-385, X028, and X029 removed and replaced with A-723, A-785, A-787, C-2068, and C-2071. Increase in blanket gas activity noted during transfer of subassembly X028 from core to basket.
4/21/68*	Administrative approval for power operation awaited.
4/22/68*	Primary purification system heated up. Nitrogen level reduced in primary blanket-gas system by purging with argon.
4/23/68*	Flow through bypass in primary purification system established.

*Administrative approval for power operation awaited.

B. Chronology of Principal Events (continued)

DATE	EVENT
4/24/68*	Primary purification system in operation with flow through cold trap. Test completed of interconnecting duct for cooling exhaust system of thimble cooling shield. Timed rod drops from 14. in. with and without air assist completed.
4/25/68*	Additional drop tests on control rods Nos. 1, 4, 5, 6, 7, 9, 10, and 11 performed without air assist. Reactor started. Power 50 kW. Reactor scrammed due to primary pump No. 2.
4/26/68*	Reactor restarted and calibration of control rods begun. Reactor shut down for work on primary-pump flow instruments. Reactor at 500 kW and rod drops started. Approval to go to power in accordance with the plan of action received. 5-MW power level attained.
4/27/68	Purge on primary gas blanket secured. Reactor operated at 5 MW for 10 hours then shut down for gas sample. Reactor started up again. Gas samples taken and PRD measurements made from 50 kW to 45 MW.
4/28/68	PRD measurements completed for Run 27H; value of 38 Ih obtained. Reactor operation continued at 45 MW.
4/30/68	Reactor power 45 MW. Secondary cold trap put in operation.
5/2/68	Reactor power 45 MW. Power reduced for PRD data and reduced-flow test. Reactor scram caused by "Bulk Sodium Temperature High" while doing reduced-flow test. Secondary cold trap shut down. Subassemblies C-2068, A-723, and A-788 removed from core and replaced with X028, B-386, and B-384. Significant increase in gas activity noted when X028 replaced in core and primary pumps started.
5/3/68	Reactor started up and held at low power for period calibration of rod No. 5. PRD measurements begun from 50 kW to 45 MW in Run 27I.
5/4/68	PRD measurements completed for Run 27I. Operation continued at 45 MW to confirm X028 as the leaking subassembly.
5/5/68	Reactor power 45 MW.
5/6/68	Reactor power 45 MW. Alarm received from Fission Gas Monitor (FGM). Reactor shut down, ending Run 27. Reactor building temporarily on limited access. Unrestricted fuel handling begun. Subassemblies B-385 and C-2071 removed and replaced with A-788 and X029.

B. Chronology of Principal Events (continued)

DATE	EVENT
5/7/68	Subassemblies C-2070, C-2062, A-798, A-733, and X028 removed, and C-2010, C-2012, B-374, B-395, and C-2068 installed. Increase in gas activity noted when removing X028. Primary purification system in operation. Unrestricted fuel handling continued. Subassemblies C-2034, C-2057, B-362, A-821, B-364, C-2033, and C-2037 removed from the core and replaced with C-2064, C-2049, B-372, X038, B-384, C-2129, and C-2070.
5/8/68	Fuel handling continued. Source (SO-1920) removed from position 8-A-4. Unrestricted fuel handling completed. Subassemblies C-2058, C-2026, A-814, C-2040, B-367, B-361, B-365, L-457, C-2056, and S-604 removed. Subassemblies C-2130, C-2120, X037, C-2062, B-390, B-302, B-395, L-498, C-2058, and S-613 installed. Biweekly interlock check sheets and startup check sheets completed. Thimble removed and new preamp installed on channel No. 3. Check sheets completed and safety rods raised for startup.
5/9/68	Reactor started for Run 28A. Rods Nos. 5 and 10 period calibrated. All other rods intercompared. PRD measurements started. Drift tests at 15 and 25 MW performed.
5/10/68	PRD measurements continued and reduced-flow test conducted at 22.5 MW. Stainless steel rod drops performed. Reactor power lowered to 2 MW for work on cooling fan of level indicator for secondary surge tank. Reactor power raised to 22.5 MW for drift test at 58% primary-system flow.
5/11/68	Drift test at 22.5 MW, 58% flow completed. Power increased to 45 MW, 100% flow. Reactor operation at 45 MW continued.
5/12/68	Reactor power 45 MW.
5/13/68	Reactor power 45 MW. Reactor power lowered to PRD measurements and rod drops. PRD measured Reactor shut down.
5/14/68	Preamp on channel No. 3 replaced. Channel No. 3 repaired. Unrestricted fuel handling begun. Subassemblies A-813, C-2065, and A-799 removed. Subassemblies X010, C-2166, and XG04 installed.
5/15/68	Unrestricted fuel handling completed. Subassemblies B-373, A-787, B-371, A-748, C-2132, C-2064, A-789, A-735, and L-453 removed. Subassemblies X020, X031, X019, XG02, C-2136, C-2165, X032, XG03, and T-500A installed. Reactor started up and operated at 50 kW for calibration of special control

B. Chronology of Principal Events (continued)

DATE	EVENT
5/15/68 (contd.)	rod T-500A. Reactor shut down because of further problems with channel No. 3. New preamp and detector installed on channel No. 3. Subassembly T-500A removed from core and L-453 installed. Reactor restarted. Rod drops at 500 kW conducted. Power lowered to 50 kW to period calibrate rods Nos. 5 and 10.
5/17/68	All control rods intercalibrated. Power coefficient measured from 50 kW to 45 MW. PRD for Run 28B measured.
5/18/68	Reactor power 45 MW.
5/20/68	Reactor power 45 MW. Power lowered to 41.5 MW for rod-drop tests. Power lowered to 22.5 MW for reduced-flow test. Power lowered to 50 kW for work on core-subassembly outlet temperatures on ADL. ADL problems corrected.
5/21/68	Power increased to 10 MW. Power lowered to 50 kW for work on feedwater heater No. 2. Power raised to 45 MW. PRD measured. Secondary cold trap put in operation.
5/22/68	Reactor power 45 MW. Power reduced to 22.5 MW, and flow lowered for reduced-flow test. Rod drops with the stainless steel control rod performed. Drift test run. Power increased to 45 MW.
5/23/68	Reactor power 45 MW. Power lowered to 42.5 MW for drift test. Reactor shut down because of a steam leak on No. 4 feedwater heater.
5/24/68	Leak on No. 4 heater repaired. Interlock check sheets completed. Reactor started up and power increased to 45 MW. Power lowered to 22.5 MW for rod drops and drift test. Reactor power returned to 45 MW.
5/25/68	Reactor power 45 MW. Power reduced to 42.5 MW for drift test. Reactor power raised to 45 MW.
5/26/68	Reactor power 45 MW. Power coefficient measurements started from 45 MW to 500 kW.
5/27/68	PRD measurements completed. Reactor shut down for fuel handling. Secondary cold trap shut down. Unrestricted fuel handling completed. Subassemblies C-2012, C-2007, C-2010, C-2008, C-2006, and C-2009 removed from core. Subassemblies X012, XA08, X015, X033, X017, and X027 installed. Brush cleaning of large-plug seal started.

B. Chronology of Principal Events (continued)

DATE	EVENT
5/28/68	Cleaning of large-plug seal completed. New Cerrotru added to large-plug seal trough. Timed control-rod drops started.
5/29/68	Timed rod drops completed. Reactor power 50 kW for period calibration of rods Nos. 5 and 10. All other rods intercompared. Reactor scram caused by defective latch switch on No. 10 control rod. Rod calibrations completed and power coefficient measurements from 50 kW to 45 MW started.
5/30/68	PRD measurements for Run 29C completed. Reactor power 45 MW. Scram caused by low flow at reactor coolant outlet. Reactor restarted and power raised to 45 MW.
5/31/68	Reactor power 45 MW. Primary flow perturbation investigated.
6/3/68	Reactor power 45 MW. Power reduced to 22.5 MW for constant-ΔT experiment. Reactor power returned to 45 MW.
6/4/68	Reactor power 45 MW. Power reduced to 41.5 MW for rod-drop tests. Power lowered to 22.5 MW and then to 500 kW. Rod drops completed. Power raised to 25 MW for drift test.
6/5/68	Drift test at 25 MW completed. Reactor power increased to 45 MW.
6/6/68	Reactor power 45 MW. Reactor power lowered to 42.5 MW for drift test. Reactor power returned to 45 MW.
6/7/68	Reactor power 45 MW. Thimble detector and cable temperature test in progress.
6/11/68	Reactor power 45 MW. Thimble detector and cable temperature test continuing. Old Dowtherm drained from secondary-cold-trap system and replaced with new Dowtherm.
6/14/68	Reactor power 45 MW. Power reduced to 42.5 MW for drift test, then raised to 45 MW. Reactor power decreased for PRD measurements from 45 MW to 50 kW.
6/15/68	Decreasing PRD measured. Reactor shut down for fuel handling. Subassemblies C-2047, C-2062, X035, C-2124, C-2061, C-2045, X022, C-2133, and C-2041 removed. Subassemblies C-291, C-2110, A-831, C-2155, C-2164, C-2038, A-821, and C-2163 installed.
6/16/68	Unrestricted fuel handling completed. Subassemblies X038, C-2044, X026, C-2048, X031, B-382, X037, C-2043, C-2130

B. Chronology of Principal Events (continued)

DATE	EVENT
6/16/68 (contd.)	C-2120, L-451, and L-453 removed. Subassemblies C-2162, A-837, C-2072, A-813, C-2065, A-723, B-3030, A-814, C-2154, C-2062, C-2061, L-460, and L-461 installed. Cleaning of large-plug seal trough started.
6/17/68	Cleaning of large-plug seal trough completed. Most of small-plug seal trough cleaned. Oscillator rod jaws operated for checkout. Oscillator drive section removed for inspection of bellows. Rod No. 3 jaw-driver operation also checked. Cooldown of primary system started for removal of oscillator rod. Purge started of primary blanket-gas system to reduce nitrogen concentration.
6/18/68	Primary bulk sodium cooled to 580°F for oscillator rod removal. Primary purification system shut down for work on new chemistry loop. Secondary cold trap placed in operation.
6/19/68	Oscillator rod removal continued. FERD and FGM systems out of service for instrument maintenance.
6/20/68	Oscillator rod removed from core position 5-A-3 and sent to the Fuel Cycle Facility. Subassembly L-499 installed in core position 5-A-3. Secondary cold trap shut down. Installation of drive assembly for No. 8 control rod in progress.
6/21/68	Primary tank heatup to 700°F started. Biweekly and monthly interlock checks completed. FERD and FGM systems in service.
6/22/68	Problems with platform encountered while in fuel handling sequence "A". Fuel handling suspended pending investigation. Platform mechanical interlocks found damaged. Fuel handling continued while damage repaired. Purge to primary tank secured. Subassembly C-2050 removed from core position 3-F-2 and C-2064 installed. Also, X900 removed from core position 7-A-4 and A-766 installed.
6/23/68	Subassemblies A-804, X010, A-805, A-766, L-450, S-606, B-370, C-2042, B-386, B-369, C-2052, and B-366 removed. Subassemblies X900, A-804, X010, A-805, L-459, S-614, B-3035, C-2006, B-3033, B-3034, C-2156, and B-3032 installed. Subassemblies A-804, X010, A-805 were relocated. Large-plug seal-trough cleaning started.
6/24/68	Large-plug seal-trough cleaning continued. Primary tank temperature 700°F. Primary purification system heated. Cerrotru added to large- and small-plug seal troughs.

B. Chronology of Principal Events (continued)

DATE	EVENT
6/25/68	Cleaning of large-plug seal trough completed. Primary purification system placed in operation. Timed rod drops started for monthly interlock checks.
6/26/68	Timed rod drops completed. Reactor started for Run 29A. Rod No. 1 period calibrated. Rods Nos. 5 and 10 period calibrated and all others intercompared.
6/27/68	Rod calibrations completed. Primary purification system shut down and frozen for replacement of cold trap. Reactor kinetics experiments started.
6/28/68	Reactor operations continued for reference data in preparation for replacing the stainless steel blanket in Rows 7 and 8.
6/29/68	Experimental program continued.
6/30/68	Removal of Row-7 stainless steel blanket subassemblies in progress. Primary purification system shut down for cold-trap removal. Experimental subassembly X028 identified as the leaking subassembly.

C. Production Summary

	First Quarter	Second Quarter	Third Quarter	Fourth Quarter	Total FY 1968
a) Electrical MWh Generated	4721	11,538	3713	12,919	32,891
b) Possible Electrical MWh (hr x 14.5 MWe)	32,076	32,016	31,320	31,668	127,020
c) Plant Capacity Factor Electrical (%)	14.71	36.04	11.85	40.79	25.89
d) Thermal MWh Produced	19,473	39,541	13,825	46,273	119,112
e) Possible Thermal MWh (hr x 45 MWt)	99,360	99,360	97,200	98,280	394,200
f) Plant Capacity Factor Thermal (%)	19.60	39.76	14.22	47.03	30.22
g) Reactor Critical Time (hr)	697	1169	498.7	1380.0	3744.7
h) Reactor Standby Time (hr)	0	0	0	120.0	120.0
i) Reactor Availability Factor (%)	31.57	52.94	23.1	72.34	44.11
j) Time Lost Due to Secondary Sodium or Steam System (hr)	24	216	312.0	0	552
k) Plant Availability Factor (%) - Operating Days/Days for Period	30.48	43.16	22.2	29.67	31.38

C. Production Summary (continued)

Reduced Power and Shutdown Explanations

Full Power Days			24
Reduced Power Days			
4/5 -	Fission Product Release Shutdown	1	
4/7 - 4/9	Control Rod Calibration, Power Coefficient, and Kinetics Experiments	3	
4/11 -	Scram - Primary Pump Control, and Fission Product Gas Release	1	
4/15 -	Scram - Inadvertent Instrument Ground, and Fission Product Gas Release	1	
4/17 - 4/19	Power Coefficient Experiments and Fission Product Gas Release	3	
4/26 - 4/28	Power Coefficient Experiments	3	
5/2 - 5/3	Fission Product Gas Release and Fuel Replacement	2	
5/10 - 5/12	Control Rod Calibration, Power Coefficient, and Kinetics Experiments	2	
5/17 - 5/27	Control Rod Calibration and Power Coefficient	10	
5/29 - 5/30	Control Rod Calibration, Power Coefficient, and Kinetics Experiments	2	
6/3 - 6/6	Constant ΔT and Kinetics Experiments	4	
6/15 -	Power Coefficient Experiments	1	
6/26 - 6/30	Control Rod Calibration, Power Coefficient, and Kinetics Experiments	5	38

C. Production Summary (continued)

Reduced Power and Shutdown Explanations (continued)

Shutdown Days

4/6 -	Fuel Replacement Because of Fission Product Gas Release	1	
4/11 - 4/13	Fuel Replacement Because of Fission Product Gas Release	3	
4/16 -	Fuel Replacement Because of Fission Product Gas Release	1	
4/20 -	Fuel Replacement Because of Fission Product Gas Release	1	
4/21 - 4/25	Administrative Approval Awaited	5	
5/5 - 5/8	Fuel Replacement Because of Fission Product Gas Release	4	
5/14 - 5/16	Fuel Replacement Because of Fission Product Gas Release	3	
5/28 -	Fuel Replacement Because of Fission Product Gas Release and Cleaning of Rotating-Plug Seal Trough	1	
6/16 - 6/25	Spent Fuel Replacements, Oscillator Removed, Experiments Returned to Reactor	10	29

D. Plant Performance

Graphs and tables are presented as in previous reports.

1. Power Production

The reactor operated for a total of 1928 MWdt this quarter. Operating history data are given in Tables I, II, and III. Figures 1, 2, and 3 are graphs of the data for "reactor on" time and "generator on" time. Figures 4, 5, and 6 are graphs of cumulative thermal energy and cumulative electrical energy. The summary of scrams from power is given in Table IV.

Figures 7, 8, and 9 are graphs of reactor inlet temperature (bulk sodium temperature), reactor outlet temperature, and reactor power.

2. Primary System

a. Primary Pumps

Figures 10 through 21 are graphs of clutch current, generator power, speed, and flow for the main primary pumps. Flow perturbations caused by malfunctioning of primary pump No. 2 are not visible in the graphs because of the short duration of the perturbations. Except for these perturbations, operation of the pumps was normal.

b. Primary Auxiliary Pump

The auxiliary pump ran continuously throughout the quarter and with no indication of abnormal performance.

c. Coolant Temperatures

Figures 22 through 42 are graphs of subassembly outlet temperature as a function of time. The average outlet temperature at 45 MW for each run is given in Table V.

Changes in subassembly outlet temperature at 45 MW were attributed to loading changes. During the runs, temperatures maintained the same relation to power and flow, within the limits of measuring accuracy.

For core position 4-B-1, the 45-MW temperature had been 892°F during Run 27D. The special subassembly containing 17 pins with 70%-enriched fuel was removed and a standard driver subassembly was installed for Run 27E. The 7°F reduction to 885°F (3% reduction in temperature rise) is less than the 10% reduction in power production in the subassembly. Upper-plenum heat-transfer effects account for this difference. In core position 4-C-3, experiment X017 was replaced with a standard driver subassembly, and the subassembly outlet temperature changed from 815°F to 869°F. Power-production and flow-rate differences caused this change.

TABLE I

OPERATING HISTORY DATA

April 1968

Date	Reactor Critical Time	Cumulative Critical Time	Gross Thermal Energy	Cumulative Gross Thermal Energy	Gross Electrical Energy	Cumulative Gross Electrical Energy	Generator on Time	Cumulative Generator on Time	Thermal Power Range Max.	Thermal Power Range Min.
	Hr	Hr	MWt	MWt	MWe	MWe	Hr	Hr	MW	MW
1	24	11954.9	1080	387886	313	100697	24	7858.6	45	45
2	24	11978.9	1080	388966	317	101014	24	7882.6	45	45
3	24	12002.9	1080	390046	310	101324	24	7906.6	45	45
4	24	12026.9	1080	391126	312	101636	24	7930.6	45	45
5	24	12050.9	1079	392205	312	101948	23	7953.6	45	45
6	5	12055.9	181	392386	43	101991	4	7957.6	45	0
7	7	12062.9	0	392386	0	101991	0	7957.6	0.05	0
8	19.5	12082.4	170	392556	8	101999	3	7960.6	25	0
9	11	12093.4	103	392659	5	102004	3	7963.6	25	0
10	24	12117.4	1020	393679	300	102304	24	7987.6	45	25
11	19.3	12136.7	866	394545	271	102575	19.3	8006.9	45	0
12	0	12136.7	0	394545	0	102575	0	8006.9	0	0
13	11	12147.7	0	394545	0	102575	0	8006.9	0.05	0
14	23	12170.7	472	395017	111	102686	14	8020.9	45	0
15	24	12194.7	1080	396097	314	103000	24	8044.9	45	45
16	2	12196.7	77	396174	27	103027	2	8046.9	45	0
17	3	12199.7	0	396174	0	103027	0	8046.9	0.05	0
18	24	12223.7	608	396782	160	103187	16	8062.9	45	0
19	12.4	12236.1	562	397344	163	103350	12	8074.9	45	0
20	0	12236.1	0	397344	0	103350	0	8074.9	0	0
21	0	12236.1	0	397344	0	103350	0	8074.9	0	0
22	0	12236.1	0	397344	0	103350	0	8074.9	0	0
23	0	12236.1	0	397344	0	103350	0	8074.9	0	0
24	0	12236.1	0	397344	0	103350	0	8074.9	0	0
25	4	12240.1	0	397344	0	103350	0	8074.9	0.05	0
26	18	12258.1	13	397357	0	103350	0	8074.9	5	0
27	23	12281.1	352	397709	35	103385	4	8078.9	40	0
28	23	12304.1	1035	398744	300	103685	23	8101.9	45	40
29	24	12328.1	1080	399824	313	103998	24	8125.9	45	45
30	24	12352.1	1080	400904	319	104317	24	8149.9	45	45

TABLE II

OPERATING HISTORY DATA

May 1968

Date	Reactor Critical Time	Cumulative Critical Time	Gross Thermal Energy	Cumulative Gross Thermal Energy	Gross Electrical Energy	Cumulative Gross Electrical Energy	Generator on Time	Cumulative Generator on Time	Thermal Power Range Max.	Thermal Power Range Min.
	Hr	Hr	Mwt	MWt	MWe	MWe	Hr	Hr	MW	MW
1	24	12376.1	1080	401984	318	104635	24	8173.9	45	45
2	10	12386.1	313	402297	102	104737	10	8183.9	45	0
3	8	12394.1	39	402336	0	104737	0	8183.9	15	0
4	24	12418.1	931	403267	275	105012	22	8205.9	45	15
5	24	12412.1	1080	404347	112	105124	9	8214.9	45	45
6	6	12448.1	251	404598	71	105195	5.6	8220.5	45	0
7	0	12448.1	0	404598	0	105195	0	8220.5	0	0
8	0	12448.1	0	404598	0	105195	0	8220.5	0	0
9	22	12470.1	167	404765	0	105195	0	8220.5	25	0
10	24	12494.1	694	405459	199	105394	17	8237.5	41.5	2
11	24	12518.1	1023	406482	293	105687	24	8261.5	45	22.5
12	24	12542.1	1080	407562	336	106023	24	8285.5	45	45
13	21.3	12563.4	728	408290	208	106231	17	8302.5	45	0
14	0	12563.4	0	408290	0	106231	0	8302.5	0	0
15	6	12569.4	0	408290	0	106231	0	8302.5	0.05	0
16	8	12577.4	0	408290	0	106231	0	8302.5	0.05	0
17	24	12601.4	498	408788	139	106370	10.4	8312.9	45	0.05
18	24	12625.4	1080	409868	318	106688	24	8336.9	45	45
19	24	12649.4	1015	410883	282	106970	23	8359.9	45	10
20	24	12673.4	631	411514	169	107139	18	8377.9	45	0.05
21	24	12697.4	108	411622	23	107162	2	8379.9	45	0.05
22	23	12720.4	763	412385	200	107362	19	8398.9	45	0
23	16	12736.4	626	413011	185	107547	15	8413.9	45	0
24	16	12752.4	458	413469	130	107677	12	8425.9	45	0
25	24	12776.4	1045	414514	296	107973	24	8449.9	45	27.5
26	24	12800.4	1004	415518	283	108256	24	8473.9	45	20
27	4.2	12804.6	33	415551	2	108258	0.3	8474.2	20	0
28	0	12804.6	0	415551	0	108258	0	8474.2	0	0
29	14	12818.6	31	415582	0	108258	0	8474.2	10	0
30	21.5	12840.1	600	416182	163	108421	15.5	8489.7	45	0
31	24	12864.1	1080	417262	319	108740	24	8513.7	45	45

TABLE III

OPERATING HISTORY DATA

June 1968

Date	Reactor Critical Time	Cumulative Critical Time	Gross Thermal Energy	Cumulative Gross Thermal Energy	Gross Electrical Energy	Cumulative Gross Electrical Energy	Generator on Time	Cumulative Generator on Time	Thermal Power Range Max.	Thermal Power Range Min.
	Hr	Hr	MWt	MWt	MWe	MWe	Hr	Hr	MW	MW
1	24	12888.1	1080	418342	319	109059	24	8537.7	45	45
2	24	12912.1	1080	419422	319	109378	24	8561.7	45	45
3	24	12936.1	792	420214	228	109606	24	8585.7	45	22.5
4	22	12958.1	596	420810	166	109772	15	8600.7	45	0
5	24	12982.1	1004	421814	272	110044	24	8624.7	45	25
6	24	13006.1	1067	422881	315	110359	24	8648.7	45	42.5
7	24	13030.1	1080	423961	330	110689	24	8672.7	45	45
8	24	13054.1	1080	425041	330	111019	24	8696.7	45	45
9	24	13078.1	1080	426121	332	111351	24	8720.7	45	45
10	24	13102.1	1080	427201	343	111694	24	8744.7	45	45
11	24	13126.1	1074	428275	340	112034	24	8768.7	45	37.5
12	24	13150.1	1080	429355	342	112376	24	8792.7	45	45
13	24	13174.1	1080	430435	352	112728	24	8816.7	45	45
14	24	13198.1	1059	431494	325	113053	24	8840.7	45	40
15	8	13206.1	122	431616	38	113091	4	8844.7	40	0
16	0	13206.1	0	431616	0	113091	0	8844.7	0	0
17	0	13206.1	0	431616	0	113091	0	8844.7	0	0
18	0	13206.1	0	431616	0	113091	0	8844.7	0	0
19	0	13206.1	0	431616	0	113091	0	8844.7	0	0
20	0	13206.1	0	431616	0	113091	0	8844.7	0	0
21	0	13206.1	0	431616	0	113091	0	8844.7	0	0
22	0	13206.1	0	431616	0	113091	0	8844.7	0	0
23	0	13206.1	0	431616	0	113091	0	8844.7	0	0
24	0	13206.1	0	431616	0	113091	0	8844.7	0	0
25	0	13206.1	0	431616	0	113091	0	8844.7	0	0
26	12	13218.1	1	431617	0	113091	0	8844.7	0.5	0
27	24	13242.1	175	431792	16	113107	3	8847.7	22.5	0.05
28	24	13266.1	483	432275	8	113115	1	8848.7	41.5	10
29	20	13286.1	208	432483	26	113141	3	8851.7	30	0.05
30	24	13310.1	596	433079	162	113303	19	8870.7	25	5

TABLE IV

SUMMARY OF SCRAMS FROM POWER

(April 1, 1968 through June 30, 1968)

Date	Time	Power Level	Trip	Remarks	Time	Date
4/8/68	1304	28 MW	Primary Pump No. 2	1	1706	4/8/68
4/9/68	0015	10 MW	No Annunciation	2	1540	4/9/68
4/16/68	0142	45 MW	Low Primary Flow	3	----	----
5/2/68	0937	22.5 MW	Bulk Sodium High Temperature	3	----	----
5/22/68	0650	22.5 MW	Reactor Coolant High Pressure No. 2 Low Flow	4	0855	5/22/68
5/30/68	1429	45 MW	Reactor Coolant Outlet Low Flow	5	1920	5/30/68
6/29/68	1555	5 MW	Earthquake	6	2052	6/29/68

1. Reference voltage failure in primary-pump control circuit.

2. Special recorders on primary pump No. 2 indicated a flow decrease. A later evaluation showed this to be the cause of the scram.

3. Inadvertent trip during checking of flow recorder. Reactor remained shut down for fuel handling because of fission-product gas release following the scram.

4. During reduced-flow tests, trip levels were not adjusted to account for this special operating condition.

5. The suspected cause of this scram was a momentary open circuit in a slide wire of the temperature compensating circuit for flow measurement. A design change is under consideration in which the slide wire would be replaced by fixed resistance steps.

6. The scram is suspected to have been caused by a momentary poor contact in the electrical circuit. The fact that there was no earthquake was verified with other autorities. Relay contacts in the detector were cleaned. A tremor was reported by Dugway Proving Grounds seismograph at 1544 on this date with a center located 250 miles north. This tremor was reported as a low-intensity tremor with a Richter number of two (2). There is no explanation for the time difference (if the two events were related) or why such a low intensity would upset the system.

c. Coolant Temperatures (continued)

TABLE V

SUBASSEMBLY OUTLET TEMPERATURES AT 45 MW

(Temperature °F)

Core Position	Run 27E	Run 27F	Run 27G	Run 27H	Run 28A	Run 28B	Run 28C
1-A-1	825	824	827	823	825	825	821
2-A-1	827	825	830	826	824	823	821
2-B-1	804	806	810	808	814	823	815
2-C-1	826	826	828	825	825	827	822
2-D-1	800	802	799	800	806	810	798
2-E-1	818	822	826	822	830	830	827
2-F-1	769	820	820	814	822	820	816
3-B-1	854	856	856	852	845	848	844
3-C-1	843	843	843	840	842	840	838
3-F-1	811	828	833	828	836	836	833
4-B-1	885	884	885	881	884	897	892
4-C-3	869	873	871	868	791	789	816
4-F-3	842	841	846	841	843	844	840
5-C-2	842	847	842	840	863	861	857
6-C-4	860	864	852	856	850	849	850
7-A-3	831	832	834	832	826	827	829
7-D-4	726	726	728	728	728	735*	735*
7-F-4	744	748	747	744	745	750	750
9-E-4	842	838	844	844	840	846	843
12-E-6	813	812	819	820	818	820	823
16-E-9	811	811	825	820	818	820	822

*Plotted data in Figure 41 about 8°F lower. The difference is believed to be caused by an error in the measuring system which makes the plotted values low.

c. Coolant Temperatures (continued)

At the beginning of Run 27F the half driver in core position 2-F-1 was replaced with experimental subassembly X034. This loading change accounts for the change in temperature from 769° to 820°F measured above position 2-F-1. This loading change also caused an increase from 811° to 828°F in position 3-F-1, owing to the reduction in cooling of the thermocouple by coolant coming from position 2-F-1.

Loading changes prior to Run 28A included substitution of a half driver in place of a full driver in core position 4-C-3. The outlet temperature was reduced to 791°F, which is a 45.8% reduction in temperature rise compared with the ≈50% reduction in power generation. This change also reduced the temperature for position 6-C-4. A reverse loading change occurred in position 4-C-2, where a half driver was replaced by a full driver. This caused the measured temperature for position 5-C-2 to increase from 840° to 863°F. Upper-plenum heat transfer caused the Row-4 flow to affect temperatures measured above Rows 5 and 6.

A special subassembly containing 37 pins with 70%-enriched fuel was installed in position 4-B-1 at the start of Run 28A. This caused an increase of about 32.5% in power production in this core position, compared with a 7.1% increase in temperature rise. Again, upper-plenum heat transfer is believed to be the primary cause of this difference.

In core position 4-C-3, experiment X017 replaced a half driver at the beginning of Run 28C. A low flow rate for the experiment caused a higher outlet temperature.

A mathematical model is being developed for computing subassembly outlet temperatures. The model takes into account heat-transfer effects in the upper plenum and radial heat transfer between subassemblies, in addition to subassembly flow and power generation. The model will be checked against data from completed reactor power runs.

d. Primary Sodium Chemistry

1) Primary Sodium Sampling

Table VI lists the primary sodium samples taken during the quarter, the type of sample container, and the intended analysis.

2) Primary Purification System

Figures 43 through 48 show purification system performance for each month of the quarter. The primary plugging temperature remained less than 225°F during the quarter. The plugging temperature is not measured below 225°F because of the proximity to the freezing point of sodium.

3) Primary-Sodium Impurity Analysis

Results from analyses of primary sodium samples are listed in the following tables:

Table VII, Trace Metals in Primary Sodium

Table VIII, Radionuclides in Primary Sodium

Table IX, Carbon, Oxygen, and Hydrogen in Primary Sodium

Table X, Tritium in Primary Sodium

e. Primary-System Cover-Gas Analysis

Table XI lists high, low, and average values of hydrogen and nitrogen in the primary-system cover gas for each week of the quarter. Data are taken from the continuous gas chromatograph.

Grab samples of primary cover gas are taken at least once per shift when the reactor is operating and the samples are analyzed for radioisotopes. Figures 49, 50, and 51 show Xe-133, Xe-135, and A-41 activity levels for each month of the quarter. Except for fission-gas releases from fuel, which are noted on the figures, the xenon activities result from fission of uranium contamination on fuel element surfaces. Argon activity results from neutron activation of the argon cover gas.

3. Secondary System

a. Secondary Sodium Pump

Figures 52 through 54 show the secondary-sodium flow and the power supplied to the pump. No significant change in pump performance was noted.

b. Secondary Sodium Chemistry

1) Secondary Sodium Sampling

Table XII lists the secondary sodium samples, the type of container, and the intended analysis.

2) Secondary Purification System

Table XIII shows purification system performance for the quarter. Table XIV shows the plugging temperature of the secondary sodium for each shift. The plugging temperature is not measured below 225°F because of the proximity to the freezing point of sodium.

TABLE VI

PRIMARY SODIUM SAMPLES

Date	Container	Analysis
4/3/68	Quartz Beaker	Activity
4/6/68	Quartz Beaker	Activity
4/19/68	Quartz Beaker	Activity
4/23/68	Quartz Beaker	Activity
4/24/68	Quartz Beaker	Activity
4/24/68	1-in. Al Tube	Historical
4/25/68	Quartz Beaker	Activity
4/30/68	Tantalum Crucible	Test of Lab Distillation Equipment
4/30/68	Quartz Beaker	Cyanide
4/30/68	Extrusion Vessel	Carbon
5/2/68	Quartz Beaker	Activity
5/6/68	Quartz Beaker	Activity
5/9/68	Quartz Beaker	Activity
5/9/68	Quartz and Ni Beakers	Activity
5/9/68	1/2-in. SS Tube	Oxygen, Hydrogen
5/14/68	Quartz Beaker	Cyanide
5/14/68	Quartz Beaker	Activity
5/14/68	1-in. Al Tube	Historical
5/17/68	Quartz Beaker	Trace Metals
5/28/68	Quartz Beaker	Sn, Bi
5/28/68	Quartz Beaker	Activity
5/28/68	1/2-in. Ni Tube	Oxygen

TABLE VI (continued)

Date	Container	Analysis
6/3/68	1/2-in. Ni Tube	Oxygen, Hydrogen
6/3/68	Quartz Beaker	Activity
6/3/68	Quartz Beaker	Activity
6/3/68	Tantalum Crucible	Test of Lab Distillation Equipment
6/11/68	Quartz Beaker	Emission Spec.
6/11/68	Tantalum Crucible	Test of Lab Distillation Equipment
6/11/68	1-in. Al Tube	Historical
6/26/68	Two Special Containers	Sent to Fred Smith, RE
6/26/68	Extrusion Vessel	Carbon
6/26/68	Quartz Beaker	Trace Metals

TABLE VII

TRACE METALS IN PRIMARY SODIUM

Date	Co	Mn	Ni	Fe	Cu	Mg	Bi	Cu
5/17/68	<0.2	<0.06	<0.2		<0.3		1.7	
5/28/68							<1.5	
6/26/68	<0.5	<0.13	<0.6	<0.6	<0.3	0.14	1.3	<0.2

Date	Sn	Pb	Ag	Cd
5/17/68	16.0	10.2	<0.4	
5/28/68	20.0			
6/26/68	19.3	11.5		<0.2

TABLE VIII

RADIONUCLIDES IN PRIMARY SODIUM

(μCi/g)

Date	Cs-137	I-131	I-133
4/6/68	1.6×10^{-2}	2.0×10^{-3}	
4/23/68	1.6×10^{-2}	9.3×10^{-3}	
4/25/68	1.6×10^{-2}	9.7×10^{-3}	
5/2/68	1.5×10^{-2}	2.3×10^{-3}	
5/6/68	1.6×10^{-2}	3.9×10^{-3}	$3.3 \times 10{-3}$
5/9/68	1.6×10^{-2}	3.2×10^{-3}	
5/14/68	1.6×10^{-2}	1.9×10^{-3}	
5/28/68	1.6×10^{-2}	6.5×10^{-4}	
6/3/68	1.5×10^{-2}	3.9×10^{-4}	
7/16/68	1.4×10^{-2}	2.2×10^{-4}	

TABLE IX

CARBON, OXYGEN, AND HYDROGEN IN PRIMARY SODIUM
(ppm)

Date	Carbon	Oxygen*	Hydrogen
3/5/68		22	1.6
4/30/68	3.3 ± 1.2		
6/3/68		10	1.6
6/26/68	4.1 ± 0.4		

*Oxygen contamination is suspected since the plugging temperature was < 225°F.

TABLE X

TRITIUM IN PRIMARY SODIUM
(pCi/cc)

Date	H-3
3/7/63*	< 150
7/9/65*	{ 2540 3340
11/14/67	1840
2/5/68	1740

*Historical Samples

TABLE XI

PRIMARY-SYSTEM COVER-GAS ANALYSIS

Date Week Ending	Gas	High*	Low	Average
4/8/68	H_2 (ppm)	12	4	5
	N_2 (ppm)	5,600	4,000	4,700
4/16/68	H_2 (ppm)	224	0	8
	N_2 (ppm)	9,800	5,300	7,500
4/23/68	H_2 (ppm)	84	0	8
	N_2 (ppm)	24,000	8,700	11,800
4/30/68	H_2 (ppm)	36	4	8
	N_2 (ppm)	8,400	2,400	4,800
5/7/68	H_2 (ppm)	64	4	8
	N_2 (ppm)	5,600	2,800	4,000
5/14/68	H_2 (ppm)	112	0	12
	N_2 (ppm)	6,800	2,800	4,000
5/21/68	H_2 (ppm)	112	0	12
	N_2 (ppm)	6800	4400	5600
5/28/68	H_2 (ppm)	12	0	4
	N_2 (ppm)	10,800	5,200	6,800
6/4/68	H_2 (ppm)	108	0	8
	N_2 (ppm)	11,000	7,600	8,800
6/11/68	H_2 (ppm)	33	0	4
	N_2 (ppm)	8,200	6,800	7,200
6/18/68	H_2 (ppm)	164	2	6
	N_2 (ppm)	8,000	6,600	7,400
6/25/68	H_2 (ppm)	120	2	28
	N_2 (ppm)	7,700+	2,900	3,600

* High hydrogen concentrations occurred coincident with fuel handling operations.

TABLE XII

SECONDARY SODIUM SAMPLES

Date	Container	Analysis
4/1/68	Quartz Beaker	Trace Metals
4/5/68	Quartz Beaker	Activity
4/15/68	Extrusion Vessel	Carbon
4/15/68	1-in. Al Tube	Historical
4/23/68	Quartz Beaker	Emission Spec.
5/10/68	Quartz Beaker	Trace Metals
5/14/68	Quartz Beaker	Cyanide
5/14/68	1-in. Al Tube	Historical
5/15/68	Quartz Beaker	Emission Spec.
5/15/68	1/2-in. Ni Tube	Oxygen, Hydrogen
5/20/68	Quartz Beaker	Activity
6/4/68	Extrusion Vessel	Carbon,
6/4/68	1/2-in. Ni Tube	Oxygen, Hydrogen
6/5/68	Quartz Beaker	Trace Metals
6/5/68	1-in. Al Tube	Historical
6/6/68	Quartz Beaker	Trace Metals
6/11/68	Quartz Beaker	Emission Spec.
6/12/68	Quartz Beaker	Activity
6/12/68	Al Crucible	Test of Lab Distillation Equipment
6/13/68	Tantalum Crucible	Test of Lab Distillation Equipment
6/14/68	Tantalum Crucible	Test of Lab Distillation Equipment

TABLE XIII

SECONDARY-SODIUM PURIFICATION-SYSTEM PERFORMANCE

Date	Time	Receive Pump Current (amps)	Total Flow (gpm)	Purification Flow (gpm)	System Diff. Press. (psia)
5/1/68	0030	22.0	20.5	7.5	9.0
	0430	22.0	20.0	7.0	9.5
	0830	22.0	19.0	6.5	9.4
	1230	22.0	19.0	7.0	9.7
	1630	22.5	19.0	7.5	9.7
	2030	22.0	19.0	7.5	9.7
5/2/68	0030	22.0	19.0	7.0	9.60
	0430	22.0	19.0	7.0	9.65
	0830	22.0	18.0	7.0	9.70
5/22/68	0030	22.0	20.0	6.5	9.25
	0430	22.3	20.0	6.5	9.20
	0830	22.6	20.0	8.8	10.0
	1230	22.5	19.0	8.0	9.8
	1630	22.3	20.0	7.8	9.95
	2030	22.3	20.0	7.3	9.65
5/23/68	0030	22.5	20.0	7.8	9.70
	0430	22.4	20.0	7.3	9.75
	0830	22.3	20.0	7.5	9.70
	1230	22.4	20.0	7.3	9.70
6/18/68	0600	21.6	20.0	5.5	8.6
	0630	21.6	20.0	5.5	8.6
	1230	21.6	20.0	7.5	9.7
	1630	21.7	20.0	7.6	9.9
	2030	21.8	20.0	7.6	9.9
6/19/68	0830	22.5	20.0	7.5	9.7

TABLE XIV

SECONDARY SODIUM PLUGGING TEMPERATURES

Date	Shift 1	Shift 2	Shift 3
4/1/68		all <225°F	
4/2/68	<225°F	<230°F	245°F
4/3/68	245	245	250
4/4/68	245	245	---
4/5/68	235	240	240
4/6/68	260	230	230
4/7/68	<225	<230	260
4/8/68	225	235	---
4/9/68	225	<225	<225
4/10/68	240	250	250
4/11/68	<225	240	235
4/12/68	<225	230	---
4/13/68	240	245	240
4/14/68	235	---	240
4/15/68	<225	235	235
4/16/68	235	235	235
4/17/68	245	240	<225
4/18/68	230	---	<225
4/19-4/21/68		all <225°F	
4/22/68	245	245	250
4/23/68	245	245	230
4/24/68	245	245	240
4/25/68	245	250	250
4/26/68	250	255	250
4/27/68	255	230	245
4/28/68	250	245	245
4/29/68	270	245	250
4/30/68	265	270	275
5/1/68	270	250	<225
5/2-5/5/68		all <225°F	
5/6/68	235	235	240

TABLE XIV (continued)

Date	Shift 1	2	3
5/7/68	250°F	240°F	<225°F
5/8/68	250	225	<225
5/9/68	230	<235	235
5/10/68	235	240	235
5/11/68	235	245	245
5/12/68	<225	235	235
5/13/68	230	235	---
5/14/68	240	245	240
5/15/68	245	---	250
5/16/68	240	250	250
5/17/68	250	235	240
5/18/68	240	245	265
5/19/68	235	245	260
5/20/68	---	270	265
5/21/68	260	260	250
5/22/68	<225	230	225
5/23-5/29/68		all <225°F	
5/30/68	<225	230	235
5/31/68	230	<225	---
6/1/68	<225	235	---
6/2/68	250	245	---
6/3/68	260	240	245
6/4/68	250	255	255
6/5/68	250	250	250
6/6/68	245	230	250
6/7/68	245	---	240
6/8/68	235	240	250
6/9/68	260	255	275
6/10/68	265	265	270
6/11/68	260	---	---
6/12/68	265	---	270
6/13/68	275	265	---

TABLE XIV (continued)

Date	Shift 1	Shift 2	Shift 3
6/14/68	270°F	280°F	265°F
6/15/68	275	275	275
6/16/68	260	260	270
6/17/68	265	265	275
6/18/68	265	240	235
6/19-6/26/68		all <225°F	
6/27/68	235	235	235
6/28/68	230	235	---
6/29/68	235	235	---
6/30/68	250	250	245

3) Secondary Sodium Impurity Analysis

Results from analyses of secondary sodium samples are listed in the following tables:

Table XV, Trace Metals in Secondary Sodium

Table XVI, Radionuclides in Secondary Sodium

Table XVII, Carbon, Oxygen, and Hydrogen in Secondary Sodium

c. Secondary-System Cover-Gas Analysis

Table XVIII lists high, low, and average values of hydrogen and nitrogen in the secondary-system cover gas for each month of the quarter.

TABLE XV

TRACE METALS IN SECONDARY SODIUM

(ppm)

Date	Cu	Ni	Co	Mn	Mg	Bi	Sn	Fe	Pb*	Ag
4/1/68	0.5	<1.0	<0.9	0.4	0.4			3.0		
5/10/68	<0.3	<0.4	<0.2	<0.1		1.0	<0.5	<3.0	11.4	<0.4
6/5/68 } 6/6/68	<0.3	<0.3	<0.2	<0.06		1.0	<0.3	<1.0	<1.0	<0.4

*Additional analyses are required to eliminate the discrepancy in lead values.

TABLE XVI

RADIONUCLIDES IN SECONDARY SODIUM

(μCi/g)

Date	Na-24
4/5/68	3.1×10^{-2}
5/20/68	3.2×10^{-2}
6/12/68	3.2×10^{-2}

TABLE XVII

CARBON, OXYGEN, AND HYDROGEN IN SECONDARY SODIUM

(ppm)

Date	Carbon	Oxygen	Hydrogen
4/8/68		18	
4/15/68	4.2		
5/15/68		16	4.7
6/4/68	4.5	9	2.2

TABLE XVIII

SECONDARY-SYSTEM COVER-GAS ANALYSIS

Date Week Ending	Gas	Concentration (ppm) High	Low	Avg.
4/8/68	H_2	0	0	0
	N_2	1700	1400	1550
4/16/68	H_2	0	0	0
	N_2	1500	1200	1350
4/23/68	H_2	0	0	0
	N_2	1900	1200	1600
4/30/68	H_2	8	0	1
	N_2	1400	1000	1100
5/7/68	H_2	20	0	6
	N_2	1600	1100	1400
5/14/68	H_2	0	0	0
	N_2	1400	1100	1300
5/21/68	H_2	0	0	0
	N_2	1700	1100	1400
5/28/68	H_2	0	0	0
	N_2	1600*	300	400
6/4/68	H_2	0	0	0
	N_2	300	300	300
6/11/68	H_2	0	0	0
	N_2	300	300	300
6/18/68	H_2	4	0	0
	N_2	500	300	350
6/25/68	H_2	0	0	0
	N_2	400	200	300

*On 5/22/68 a slight air leak in the sample line at a flange between the sodium surge tank and the vapor trap was repaired.

d. Performance of Intermediate Heat Exchanger and Steam Generator

1) Steam Generator Performance

Calculations have been made to determine the performance at 45 MWt of the two parallel superheaters in the steam generating system. The purpose of the analysis is to determine the superheater heat-transfer coefficient so that any change in superheater performance can be determined and so that the coefficient can be compared with the calculated design coefficient. This comparison will determine the extent to which the present design correlations allow prediction of the actual coefficient.

The performance of the heat-transfer equipment is expressed by the overall heat-transfer coefficient. This may be determined by the following relationship for a single-pass countercurrent heat exchanger:

$$U = \frac{Q}{A} \frac{1}{(T_i - t_o) - (T_o - t_i)} \ln \left[\frac{T_i - t_o}{T_o - t_i} \right], \tag{1}$$

or utilizing heat balances on both streams,

$$U = \frac{1}{A} \frac{1}{(1/WC - 1/wc)} \ln \frac{T_i - t_o}{T_o - t_i}, \tag{2}$$

where

U = Overall heat-transfer coefficient, Btu/hr ft^2°F,

Q = Heat load, Btu/hr,

A = Heat transfer area, ft^2,

T,t = Temperature, °F,

W,w = Flow rate, lb$_m$/hr,

C,c = Specific heat, Btu/lb$_m$°F,

and where the capital letters refer to the hot fluid, secondary sodium, while the lower case letters refer to the cooler fluid, steam. Subscripts i and o refer to the inlet and outlet conditions, respectively. In deriving equation (1) it was assumed that the specific heat of steam and the overall heat-transfer coefficient were constant. As the specific heat of steam is quite temperature-dependent near the saturation temperature, varying by approximately 1%/°F, equation (1) cannot be used directly to obtain the overall heat-transfer coefficient. Instead, it was necessary to consider the exchanger as a number of small units in which the temperature change of the fluids was relatively small and to use equation (2) to calculate the temperatures in each unit. Starting at the cold end of the exchanger, equation (2) was used to calculate the hot-end temperatures of a unit which, in turn, were the cold end temperatures for the next unit. This procedure was used until the total heat-

1) <u>Steam Generator Performance</u> (continued)

transfer area of the exchanger was realized. The calculated overall heat-transfer coefficient was obtained from the following correlations. For the sodium on the shell side:

$$Nu = 0.212\ (D_{eq}\ Re\ Pr)^{0.6} \tag{3}$$

For the steam in the annular tubes:

$$Nu = 0.023\ Re^{0.8}\ Pr^{0.4} \tag{4}$$

The wall resistance was obtained from thermal conductivity data found in the literature.

Table XIX presents the data used to evaluate the superheater performance. The temperature data for the exit sodium and steam streams indicate that the heat load on the two parallel superheaters is not equal. By using the measured temperatures for a heat balance and by utilizing a mass balance, the flow rates to each unit were calculated, and are shown in Table XIX. The calculated sodium flow differs by 8% in comparison to assuming that each unit has equal flow. The calculated steam flow differs by 20% in comparison to assuming that each unit has equal flow. Table XIX also shows the heat balance for each unit based on the experimental data and on the calculated flow distribution. The heat balance as based on the calculated flow distribution indicates that the heat load on the units differs by approximately 1/3.

By use of the calculated flow rates as well as assuming equal flow in each unit, the heat-transfer coefficient was calculated from equations (3) and (4) and used in equation (2) to obtain the fluid temperature at the hot end of the exchanger. The results are shown in Table XX. The duty of the superheaters was overestimated by approximately 12%. The heat-transfer coefficient had to be reduced by approximately 30% to allow the calculated steam outlet temperature to match the experimental temperature. The percentage of resistance to heat transfer in the superheater is given in Table XXI for three different parts of the exchanger. The sodium stream resistance is a small fraction of the total resistance. Assuming that the thermal conductivity of 2-1/4 Cr-1 Mo alloy steal is accurate, the overprediction of the heat-transfer coefficient would be due to the steam coefficient as related by equation (4). It appears that this correlation overpredicts the actual heat transfer by about 50%. Assuming equal flow in each unit, the calculated overall heat-transfer coefficient varied from 270 at the cold end of the exchanger to 215 Btu/hr ft^2°F at the top of the unreinforced tube section. The reinforced tube section, at the sodium inlet, had a heat transfer coefficient of 144 Btu/hr ft^2°F. The actual coefficients would be 0.69 of the calculated coefficients.

Graphs of steam generator performance are given in Figures 55 through 57.

TABLE XIX

EBR-II SUPERHEATERS

OPERATING DATA, HEAT BALANCE, AND CALCULATED FLOW DISTRIBUTION

45-MWt REACTOR OPERATION

Measured Data (April 3, 1968)	Superheater 710	Superheater 712	Mixed Average
Sodium Flow Rate, Total, lb_m/hr			1.9×10^6
Sodium Temperature, In, °F			827.7
Sodium Temperature, Out, °F	766.9	777.9	771.9
Steam Flow Rate, Total, lb_m/hr			1.70×10^5
Steam Temperature, In, °F			577.9
Steam Temperature, Out, °F	790.3	793.9	791.9
Calculated Flow Distribution			
Sodium Flow Rate, lb_m/hr	1.06×10^6	0.89×10^6	
Steam Flow Rate, lb_m/hr	1.04×10^5	0.70×10^5	
Heat Balance			
Sodium System, Btu/hr	1.97×10^7	1.36×10^7	3.33×10^7
Sodium System, MW	5.76	3.98	9.75
Steam System, Btu/hr	1.92×10^7	1.32×10^7	3.24×10^7

lb_m = pounds mass

TABLE XX

CALCULATED TEMPERATURES AT HOT END OF SUPERHEATERS

45-MWt REACTOR OPERATION

	Superheater					
	710		712		Mixed Average	
	T_i	t_o	T_i	t_o	T_i	t_o
Measured Temperatures (°F)	827.7	790.3	827.7	793.3	827.7	791.9
Calculated Temperatures (°F)						
No Fouling						
X = 1	831.1	812.9	831.2	821.9	829.5	816.7
X = 0.75	826.4	791.0				
X = 0.63			826.5	793.9		
X = 0.69					825.0	792.1

X = Heat Transfer Coefficient Multiplier

T_i = Sodium Inlet Temperature (°F)

t_o = Steam Outlet Temperature (°F)

TABLE XXI

RESISTANCE TO HEAT TRANSFER, PERCENT OF TEMPERATURE DROP

(No Fouling)

	Regular Tubes		Shock Tubes
	Bottom	Top	
Sodium Resistance	7	6	4
Wall Resistance	33	26	38
Steam Resistance	60	68	58

2) Intermediate Heat Exchanger Evaluation

Calculations were also made to determine the performance of the EBR-II intermediate heat exchanger at a power level of 45 MWt. The heat-transfer coefficient was determined to compare it with the design coefficient and to determine any change in the coefficient with operating time.

The experimental overall heat-transfer coefficient is determined from equation (1) or (2) where the capital letters now refer to the primary sodium and the lower-case letters refer to the secondary sodium. The intermediate heat exchanger is a single-pass countercurrent heat exchanger with the primary sodium on the shell side and secondary sodium on the tube side.

The calculated overall heat-transfer coefficient was obtained from the individual conductances. The following equation was used to obtain the conductance for the tube and shell fluids:

$$Nu = 0.625\ (Re\ Pr)^{0.4} \tag{5}$$

Equation (5) was correlated for heat transfer in tubes. Because of the lack of reliable heat-transfer correlations for the unbaffled shell, it was also used for the shell fluid. The wall resistance was obtained from thermal conductivity data for 304 stainless steel. No fouling of the heat transfer surface was considered.

Table XXII gives the performance data of the intermediate heat exchanger. The calculated overall heat-transfer coefficient was 1130 Btu/hr ft^2°F. Using this coefficient and the measured temperature difference at the cold end of the exchanger, the calculated temperature difference at the hot end would be 1.8°F. The measured approach at the hot end was 2.9°F, which corresponds to a heat transfer coefficient of 1000 Btu/hr ft^2°F. Considering the errors inherent in measuring temperatures at this level, the agreement between the measured and calculated coefficients is quite close.

4. Steam System

a. Pressure and Temperature

Figures 59 through 61 are graphs of the steam temperature and pressure.

b. Turbine Generator System

The performance data for the turbine generator system are given in Figure 61. The first half of 1968 is covered. The same limitations given in the previous quarterly report are still present. Modification of instrumentation is still under consideration.

TABLE XXII

EBR-II INTERMEDIATE HEAT EXCHANGER

45-MWt REACTOR OPERATION

PERFORMANCE DATA (MAY 10, 1968)

	IN	OUT
Temperatures		
Primary Sodium, °F	832.9	705
Secondary Sodium, °F	582.9	832.9 (thermocouple)
		830 (resistance thermometer)
Flow Rates		
Primary		
gpm	8909	
lb/hr	3.84×10^6	
Secondary		
gpm	4527	
lb/hr	1.99×10^6	
Heat Balance		
Primary, Btu/hr	1.50×10^8	
Secondary, Btu/hr	1.51×10^8	
Heat-Transfer Coefficient		
Experimental, Btu/hr ft^2°F		1000
Calculated, Btu/hr ft^2°F		1130
Tube Coefficient, Btu/hr ft^2°F		3630
Shell Coefficient, Btu/hr ft^2°F		4700
Wall Coefficient, Btu/hr ft^2°F		2465

c. Water Treatment

1) Steam System

Averaged daily pH data from the power cycle streams are plotted in Figures 62, 63, and 64. Hydrazine and dissolved oxygen content of the No. 2 heater and the feedwater are shown in Figures 65, 66, and 67.

TABLE XXIII

POWER CYCLE STREAM ANALYSES

Date	ppm	Condensate	No. 2 Heater	Blowdown Demin	Feedwater	Blowdown	Steam
4/10/68	NH_3	0.50	0.64	0	0.70	0.35	0.56
4/30/68	NH_3	0.32	0.38	0	0.51	0.25	0.38
5/1/68	NH_3	0.35	0.52	0	0.58	0.32	0.52
4/29/68	Cl	0	0	0	0	0	0
5/1/68	Cl	0	0	0	0	0	0
5/2/68	Cl	0	0	0	0	0	0
5/6/68	Cl	0	0	0	0	0	0
5/10/68	Cl	0	0	0	0	0	0
5/13/68	Cl	0	0	0	0	0	0
5/17/68	Cl	0	0	0	0	0	0
5/23/68	Cl	0	0	0	0	0	0
5/14/68	Fe	0.35	0.52	0	0.55	0.33	0.52
5/22/68	Fe	0.03	0.03	0	>0.05	>0.05	0
5/20/68	Cu	0	0	0	0	0	0

2) Condenser Cooling Water

Averaged daily data from the condenser cooling water are plotted in Figures 68, 69, and 70.

3) Chromate Reduction System

Averaged daily data from the chromate reduction system are plotted in Figures 71 and 72. The system was operated for only a few hours during the month of April and, therefore, no data for April are presented.

II. Fuel Management

Loading changes for Runs 27E through 27I were made for the purpose of searching for the source of the fission gas leakage occurring in Run 27.

Loading changes for Run 28A were made to replace spent subassemblies. Two new experimental subassemblies and three "cold line" surveillance subassemblies were also installed.

Changes for Run 28B consisted of reinstalling eight experimental subassemblies that were removed during Run 27 when they were suspected as possible sources of fission gas leakage. Two subassemblies containing 37 pins each of 70%-enriched fuel were also installed in the reactor.

Loading changes for Run 28C consisted of reinstalling the remaining six experimental subassemblies removed in Run 27.

Changes for Run 29A were made to replace spent subassemblies. Seven subassemblies with high-silicon-content fuel were installed for surveillance.

A. Experimental Irradiations

Four new experimental subassemblies, X034, X035, X037, and X038, were installed in the reactor. Four experimental subassemblies were removed from the reactor: X022, X026, and X031 were removed because they had reached terminal burnup; X028 was removed because it was the source of fission gas leakage occurring during Run 27.

B. Subassembly Inventory

A total of 36 subassemblies were transferred to the Fuel Cycle Facility for examination, disassembly, and reprocessing. Thirty-eight subassemblies were transferred to the storage basket.

Ninety-seven subassemblies were available April 1, 1968, and 99 were available on June 30, 1968.

C. Core Loading Changes

The reactor loading changes for Runs 27E, 27F, 27G, 27H, 27I, 28A, 28B, 28C, and 29A are summarized in the tables that follow.

The letter prefix used in subassembly numbering has the following meaning:

- A - Depleted-uranium inner-blanket subassembly
- B - Row-6-type driver fuel subassembly
- C - Driver fuel subassembly
- L - Control-rod subassembly
- S - Safety-rod subassembly
- X - Experimental subassembly
- OSR - Oscillator Rod
- SO - Source

D. Subassembly Utilization

Calculated average utilization of the subassemblies removed before Run 28 was 92% and 80% for those removed before Run 29. Average utilization of the 31 spent subassemblies transferred to the Fuel Cycle Facility (which included subassemblies removed before several past runs) was 75%.

TABLE XXIV

SUMMARY OF INSTALLATION AND REMOVAL OF EXPERIMENTS

Run 27E	Run 27F		Run 27G	Run 27H	Run 27I
Remove	Remove	Install	Remove	Remove	Install
X012	X019	X034	X010	X028	X028
X015	X020	X035	XG02	X029	
X017	X027		XG03		
	X032		XG04		
			X033		
			X031		

Run 28A		Run 28B	Run 28C	Run 29A
Remove	Install	Install	Install	Remove
X028	X029	X010	X012	X035
	X038	XG04	XA08	X022
	X037	X020	X015	X026
		X031	X033	X038
		X019	X017	X031
		XG02	X027	X037
		X032		
		XG03		

TABLE XXV

REACTOR LOADING CHANGES

Run 27E

Date	Removed	Core Position	Installed
4/6/68	B-372	6-A-1	A-739
4/6/68	B-373	6-B-1	A-773
4/6/68	X012	4-B-2	C-2070
4/6/68	X015	4-A-2	C-2060
4/6/68	X017	4-C-3	C-2066
4/6/68	C-2138	4-B-1	C-2065
4/7/68	B-371	6-F-4	A-798

Run 27F

Date	Removed	Core Position	Installed
4/12/68	C-2009	2-F-1	X034
4/13/68	X019	6-D-2	B-371
4/13/68	X020	6-B-5	B-373
4/13/68	X027	4-B-3	C-2009
4/13/68	X032	6-F-1	A-789
4/13/68	A-813	7-B-4	X035

Run 27G

Date	Removed	Core Position	Installed
4/16/68	X010	7-F-3	A-813
4/17/68	XG02	7-A-1	A-748
4/17/68	XG03	7-D-1	A-735
4/17/68	XG04	7-B-1	A-799
4/17/68	X033	5-E-2	C-2062
4/17/68	X031	6-C-1	B-385

Run 27H

Date	Removed	Core Position	Installed
4/20/68	B-363	6-C-5	A-723
4/20/68	B-374	6-D-1	A-785
4/20/68	B-385	6-C-1	A-787
4/20/68	X028	4-D-3	C-2068
4/20/68	X029	4-E-3	C-2071

TABLE XXV (continued)

Run 27I

Date	Removed	Core Position	Installed
5/2/68	C-2068	4-D-3	X028
5/2/68	A-723	6-C-5	B-386
5/2/68	A-788	6-E-1	B-384

Run 28A

Date	Removed	Core Position	Installed
5/6/68	B-384	6-E-1	A-788
5/6/68	C-2071	4-E-3	X029
5/7/68	C-2060	4-A-2	C-2010
5/7/68	C-2070	4-B-2	C-2012
5/7/68	C-2006	4-C-2	C-2060
5/7/68	C-2066	4-C-3	C-2006
5/7/68	C-2008	3-E-2	C-2066
5/7/68	C-2062	5-E-2	C-2008
5/7/68	A-798	6-F-4	B-374
5/7/68	A-773	6-B-1	B-385
5/7/68	X028	4-D-3	C-2068
5/7/68	C-2034	4-F-1	C-2064
5/7/68	C-2057	5-B-2	C-2049
5/7/68	B-362	6-B-2	B-372
5/7/68	A-821	7-C-5	X038
5/7/68	B-364	6-D-5	B-384
5/7/68	C-2033	4-D-1	C-2129
5/8/68	C-2037	5-B-4	C-2070
5/8/68	C-2058	5-F-4	C-2130
5/8/68	C-2026	3-A-2	C-2120
5/8/68	A-814	7-C-3	X037
5/8/68	C-2040	5-E-4	C-2062
5/8/68	B-367	6-F-5	B-390
5/8/68	B-361	6-F-2	B-392
5/8/68	B-365	6-E-5	B-395

TABLE XXV (continued)

Run 28A (continued)

Date	Removed	Core Position	Installed
5/8/68	L-457	5-E-3	L-498
5/8/68	C-2056	3-D-2	C-2058
5/8/68	S-604	3-D-1	S-613
5/8/68	SO-1920	8-A-4	-----

Run 28B

Date	Removed	Core Position	Installed
5/14/68	A-813	7-F-3	X010
5/14/68	C-2065	4-B-1	C-2166
5/14/68	A-799	7-B-1	XG04
5/15/68	B-373	6-B-5	X020
5/15/68	A-787	6-C-1	X031
5/15/68	B-371	6-D-2	X019
5/15/68	A-748	7-A-1	XG02
5/15/68	C-2132	3-B-1	C-2136
5/15/68	C-2064	4-F-1	C-2165
5/15/68	A-789	6-F-1	X032
5/15/68	A-735	7-D-1	XG03
5/15/68	L-453	5-F-1	T-500A
5/16/68	T-500A	5-F-1	L-453

Run 28C

Date	Removed	Core Position	Installed
5/27/68	C-2012	4-B-2	X012
5/27/68	C-2007	4-F-2	XA08
5/27/68	C-2010	4-A-2	X015
5/27/68	C-2008	5-E-2	X033
5/27/68	C-2006	4-C-3	X017
5/27/68	C-2009	4-B-3	X027

TABLE XXV (continued)

Run 29A

Date	Removed	Core Position	Installed
6/15/68	C-2047	3-C-2	C-291
6/15/68	C-2062	5-E-4	C-2110
6/15/68	X035	7-B-4	A-831
6/15/68	C-2124	3-B-2	C-2155
6/15/68	C-2061	5-D-4	C-2164
6/15/68	C-2045	2-E-1	C-2038
6/15/68	X022	7-C-4	A-821
6/15/68	C-2133	3-C-1	C-2163
6/16/68	C-2041	1-A-1	C-2162
6/16/68	X038	7-C-5	A-837
6/16/68	C-2044	2-C-1	C-2072
6/16/68	X026	7-D-5	A-813
6/16/68	C-2048	3-E-1	C-2065
6/16/68	X031	6-C-1	A-723
6/16/68	B-382	6-A-3	B-3030
6/16/68	X037	7-C-3	A-814
6/16/68	C-2043	2-A-1	C-2154
6/16/68	C-2130	5-F-4	C-2062
6/16/68	C-2120	3-A-2	C-2061
6/16/68	L-451	5-E-1	L-460
6/16/68	L-453	5-F-1	L-461
6/20/68	OSR-#2	5-A-3	L-499
6/22/68	C-2050	3-F-2	C-2064
6/23/68	X900	7-A-4	A-766
6/23/68	A-804	7-E-1	X900
6/23/68	X010	7-F-3	A-804
6/23/68	A-805	7-F-1	X010
6/23/68	A-766	7-A-4	A-805
6/23/68	L-450	5-C-1	L-459
6/23/68	S-606	3-A-1	S-614

TABLE XXV (continued)

Run 29A (continued)

Date	Removed	Core Position	Installed
6/23/68	B-370	6-F-3	B-3035
6/23/68	C-2042	4-A-3	C-2006
6/23/68	B-368	6-B-3	B-3033
6/23/68	B-369	6-E-3	B-3034
6/23/68	C-2052	5-A-2	C-2156
6/23/68	B-366	6-A-4	B-3032

TABLE XXVI

SUBASSEMBLIES RECEIVED FROM FUEL CYCLE FACILITY

Date	S/A No.	Date	S/A No.
4/4/68	S-613	5/28/68	B-3030
4/17/68	B-384	6/13/68	L-460
4/18/68	B-386	6/13/68	L-461
4/24/68	C-2010	6/14/68	A-837
4/25/68	C-2012	6/14/68	A-831
5/13/68	C-2166	6/14/68	L-459
5/13/68	C-2165	6/15/68	L-499
5/13/68	T-500A	6/18/68	S-614
5/20/68	C-2154	6/21/68	B-3032
5/21/68	C-2162	6/21/68	B-3033
5/23/68	C-2163	6/21/68	B-3034
5/24/68	C-2164	6/22/68	C-2156
5/27/68	C-2119	6/22/68	B-3035
5/21/68	C-2155		

TABLE XXVII

EXPERIMENTAL SUBASSEMBLIES FROM FUEL CYCLE FACILITY

Date	S/A No.
4/12/68	X034
4/13/68	X035
5/4/68	X037
5/4/68	X038

TABLE XXVIII

EXPERIMENTAL SUBASSEMBLIES FROM FUEL CYCLE FACILITY COLD LINE

Date	S/A No.
4/21/68	L-498
5/3/68	C-2129
5/4/68	C-2120
5/4/68	C-2130
5/4/68	B-390
5/4/68	B-392
5/4/68	B-395
5/28/68	B-3030

TABLE XXIX

EXPERIMENTAL SUBASSEMBLIES SENT TO FUEL CYCLE FACILITY

Date	S/A No.	Burnup
4/4/68	XG05	7.17
5/28/68	X028	0.91
6/17/68	X022	----
6/28/68	X026	----

TABLE XXX

SUBASSEMBLIES TRANSFERRED TO FUEL CYCLE FACILITY

Date	S/A No.	Maximum Burnup
4/10/68	B-354	0.9964
4/10/68	B-355	0.9967
4/11/68	B-357	0.9621
4/12/68	B-358	0.9964
4/15/68	B-359	0.9622
4/16/68	C-2138	0.3310
4/18/68	B-352	0.5667
4/22/68	B-356	0.4942
4/24/68	B-360	0.7331
4/25/68	C-2003	0.6770
5/2/68	T-500A	(X)
5/13/68	C-278	1.2
5/13/68	B-363	1.08
5/15/68	B-364	1.1577
5/16/68	B-361	1.1577
5/17/68	B-367	1.1581
5/20/68	C-2132	0.4991
5/20/68	B-365	1.1563
5/21/68	C-2037	0.8998
5/22/68	C-2056	1.0684
5/23/68	C-2057	0.9000
5/24/68	C-2033	0.9682
5/27/68	C-2026	1.1183
5/28/68	C-2040	0.9000
6/3/68	C-2034	0.9683
6/4/68	L-447	0.6171
6/5/68	L-457	0.9206
6/25/68	S-606	0.8363
6/26/68	C-2124	0.6769
6/27/68	C-2133	0.8347
6/27/68	C-2041	1.1131
6/28/68	C-2144	0.8677

(X) Special control rod calibration test only

III. Reactor Physics

Table XXXI gives the pertinent reactor variables for runs completed this quarter.

TABLE XXXI

PERTINENT REACTOR VARIABLES

Run No.	Excess Reactivity Initial (Ih)	Excess Reactivity End of Run (Ih)	Control Rod* Bank (in.)	Controlling* Rod (in.)	Integrated** Power (MWdt)
27D	227	187	11.00	8.8	303
27E	215	205	11.25	8.5	90
27F	135	122	12.25	9.6	68
27G	224	***	11.00	8.2	49
27H	137	***	12.50	8.3	206
27I	183	***	11.50	8.7	96
28A	180	162	11.50	10.2	154
28B	223	166	11.50	6.9	303
28C	219	120	11.50	8.7	669

*At initial power
**At completion of run
***No measurement

A. Power Coefficient

The power-reactivity decrement was measured at the start of each run. The values obtained are listed in Table XXXII.

TABLE XXXII

POWER-REACTIVITY DECREMENT (PRD)

Run No.	U-235 (kg)	No. of Core Subassemblies	PRD (Ih)
27D	206.5	90	44
27E	201.7	87	47
27F	204.2	86	40
27G	207.4	86	42

TABLE XXXII (continued)

Run No.	U-235 (kg)	No. of Core Subassemblies	PRD (Ih)
27H	202.5	83	41
27I	205.6	85	45
28A	207.0	87	44
28B	205.2	89	47
28C	202.2	89	47

The above data are normalized to the 11.00-in. rod-bank position, and indicate the reactivity decrement in going from 0 to 45 MWt.

B. Constant ΔT Tests

When the power-reactivity decrement (PRD) is measured at two operating conditions which have the same sodium temperature rise, whatever difference in PRD is observed is due only to the difference in the temperature of the fuel elements. This is so because bowing effects and rod-bank expansion effects are dependent on the sodium temperature, which is the same in each case.

In an effort to understand the fuel element contribution to the PRD, and to ascertain whether this contribution varies substantially, a number of constant ΔT measurements have been made since Run 25. The pair of conditions for which constant ΔT comparisons are generally made are 41.7 MWt with full flow and 22.5 MWt with 54% flow.

The difference in reactivity between these two conditions in several previous runs is given in Table XXXIII. All values given there are subject to an uncertainty which is probably at least ± 1 Ih.

Most of the values taken at the beginnings of runs range from 7 to 9 Ih, but there is some evidence that these values tend to increase toward the ends of runs.

TABLE XXXIII

REACTIVITY CHANGE BETWEEN 41.7 MW, FULL FLOW AND 22.5 MW, 54% FLOW

Run No.	Measured Reactivity Change (Ih)
25	7.1
26A	8.8
26B - start	11.3

TABLE XXXIII (continued)

Run No.	Measured Reactivity Change (Ih)
26B - end	11.8
26C	14.8
27C	7.0
27H	10.1
28A	9.5
28B	9.0
28C	10.4

IV. Experimental Irradiations

A. Experimental Subassembly Locations

Figures 73 through 81 show locations of all experimental subassemblies in the core during Runs 27E, 27F, 27G, 27H, 27I, 28A, 28B, 28C, and 29A. The figures also show locations of other special subassemblies, control and safety rods, and driver subassemblies.

B. Experimental Subassembly Contents and Exposure Status

Descriptions of experimental capsules and exposures in all experimental subassemblies that have been resident in the reactor core to date are given in Table XXXIV.

V. Systems Maintenance, Improvements, and Tests

A. Mechanical and Electrical

1. Large and Small Rotating-Plug Seals

After cleaning of the large and small rotating-plug seal troughs, 244 lb and 262 lb, respectively, of seal alloy were added to the troughs to restore proper levels.

2. Primary Sodium Purification System

A small gas leak was noticed which caused loss of vacuum in the surge tank. The leak was found to be in the diaphragm of a pressure transmitter. The pressure transmitter was replaced.

The vacuum line was found to be plugged and was also cleaned.

TABLE XXXIV

SUMMARY OF CAPSULE IRRADIATIONS IN EBR-II

IRRADIATED TO 6/30/68

CAPSULES, FUEL - 288 MK-A
CAPSULES, MTLS.- 113 MK-A
CAPSULES, MTLS.- 70 MK-B-7
CAPSULES, MTLS.- 38 MK-B-19
CAPSULES, FUEL - 37 MK-B-37
CAPSULES, MTLS.- 18 MK-B-37
TOTAL 564
NO. OF SUBASSY'S 39

								FUEL CAPSULES							MATERIAL CAPSULES					
SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68	DATE INSTALLED	DATE REMOVED	FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT		MID-PLANE BURNUP RATES a/o /MWd X10^{4}		STATUS AS OF 6/30/68	NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE			STATUS AS OF 6/30/68
					MWd					MAX.	MIN.	MAX.	MIN.	% BU(MAX)			BURST TEST	TENSILE	CREEP RUPTURE	NVT X 10^{-22} TOTAL FLUX
XA01 MK-A	6D2	ANL-MET	14,000	3,940		5-6-65	3-24-66	U-Pu-Fz	19- C93 C97 C98 C99 C100 C101 CA01 CB02 CB03 CB04 CD01 CD02 CG02 CG03 CJ01 CM01 LA02 PA01 PB02	2.7	2.0	1.23	.91	0.48						
XG01 MK-A	4F2	GE	700	381		5-6-65	5-23-65	UO_2-20PuO_2	6- F1A F1B F1C F1D F1E F1F	16	14	5.78	5.08	0.22						
		GE		381											4- P1A P1B MT1 MT2	 347 347 HAST-X INCO-625 I-800 HAST-X INCO-625 I-800	 X X	 X X X X		0.14
XG02 MK-A	7A1	GE	16,700		15,039	7-16-65		UO_2-PuO_2	1- FOE	5.3		2.10		3.2						
XG03 MK-A	7D1	GE	22,500		15,039	7-16-65		UO_2-PUO_2	2- FOA FOC	5.3	4.6	2.10	1.94	3.2						

TABLE XXXIV (CON'T)
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SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX.	MIN.	MID-PLANE BURNUP RATES a/o /MWd X 10^4 MAX.	MIN.	STATUS AS OF 6/30/68 % BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
XG04 MK-A	7B1	GE	42,000		15,039	7-16-65		UO_2-PuO_2	2- FOB FOD	5.3	4.6	2.10	1.94	3.2						
XG05 MK-A	4C2	GE	13,750	12,640		9-3-65	3-6-68	UO_2-PuO_2	9- F2C F2D F2G F2H F2O F2R F2T F2V F2X	15.5	13.5	6.10	5.48	7.7	5- L2A L2C L2E L2G L21	 I-800 316 L 347 304 321	 X X X X X	 X X X X X		4.7
		ANL		12,640				UC-PuC	3- HMV-5 (NMV-11) SMV-2	19.3	18.8	5.70	5.50	7.2						
		ANL		12,640				U-15Pu-10Zr	2- NC-17 ND-24	8.6	8.5	5.27	5.18	6.7						
XG06 MK-A	4E2	GE	20,600	9317		9-3-65	2-20-67	UO_2-PuO_2	12- F2A F2B F2E F2F F2N F2P F2Q F2S F2U F2W F2Y F2Z	15.5	13.5	6.10	5.48	5.7	5- L-2'-K L-2'-M L-2'-O L-2'-P L-2'-Q	 I-800 316 L 347 321 304	 X X X X X	 X X X X X		3.6
		ANL		9317				U-15Pu-10Zr	2- NC-23 ND-23	9.2	8.6	5.63	5.26	5.2						

TABLE XXXIV (CON'T)
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SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX.	FUEL CAPSULES: POWER GENERATION KW/FT MIN.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X10^4 MAX.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X10^4 MIN.	FUEL CAPSULES: STATUS AS OF 6/30/68 %BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	MATERIAL CAPSULES: TYPE OF SAMPLE: BURST TEST	MATERIAL CAPSULES: TYPE OF SAMPLE: TENSILE	MATERIAL CAPSULES: TYPE OF SAMPLE: CREEP RUPTURE	MATERIAL CAPSULES: STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
XA07 MK-A	4D3	ANL	18,600	7950		10-27-65	12-5-66	U-15Pu-9Zr	16- ND-25 ND-26 ND-27 ND-28 ND-29 ND-30 ND-31 ND-32 ND-33 ND-34 ND-35 ND-37 ND-39 ND-41 ND-43 ND-44	9.4	8.2	5.80	5.10	4.60	3- As-9 As-10 As-11	 V-20Ti HAST-X 304			 X X X	3.2
XA08 MK-A	4F2	ANL	19,800		11,433	12-13-65		(Pu-U)C	8- HMV-1 HMV-4 HWMP-1 HWMV-1 NMP-2 NMV-4 NMV-7 NMV-12	26.0	17.2	6.20	5.40	7.1	9- As-1 As-2 As-3 As-4 As-5 As-6 As-7 As-8 As-12	 V-20Ti V-20Ti HAST-X HAST-X 304 V-20Ti HAST-X 304 V-20Ti	 X X X X X		 X X X X	4.2
		GE			11,433										2- MT-3 MT-4	 I-800 I-800	 X X	 X X		4.2
X009 MK-A	4A2	UNC	5,130	5355		3-24-66	11-14-66	PuC-UC	3- UNC-78 UNC-79 UNC-80	28.0	19.6	6.07	5.90	3.25						
		ANL		5355				PuC-UC	3- SMP-1 SMV-1 VMV-1	27.0	18.1	6.17	5.40	3.30	3- As-14 As-15 As-27	 V-20Ti V-20Ti 304		 X X X		2.1
		ANL		5355				UO_2-PuO_2	2- SOV-5 SOV-6	16.5	15.5	5.65	5.47	3.03						
		PNWL(ANL)		5355				PuO_2-S/S	2- 5P-13 4P-14	10.0	6.5	6.55	6.55	3.40	4- A-1 A-2 A-5 A-6	 304		 X X X X	 X X X X	2.1

TABLE XXXIV (CON'T)
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SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX.	MIN.	MID-PLANE BURNUP RATES a/o /MWd X10^4 MAX.	MIN.	STATUS AS OF 6/30/68 %BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X009 (CONT.) MK-A		GE		5355		3-24-66	11-14-66								2-					2.1
															L-4-C	316	X	X		
															L-4-D	316	X			
X010 MK-A	7F3 7F1	GE	19,600		11,870	3-24-66 6-25-68		UO_2-PuO_2	4-	8.6	7.7	3.18	2.84	3.8						
									FOJ											
									FOK											
									FOL											
									FOM											
		ANL			11,870										11-					2.4
															As-16	V-20Ti		X		
															As-17	V-20Ti		X		
															As-18	V-20Ti		X		
															As-19	HAST-X			X	
															As-20	V-20Ti			X	
																304				
																HAST-X				
															As-21	V-20Ti	X			
															As-22	304				
															As-23	304				
															As-24	304				
															As-25	304				
															As-26	304				
		PNWL			11,870										4-					2.4
															A-3	304		X	X	
															A-4	304		X	X	
															A-7	304		X	X	
															A-8	304		X	X	
X011 MK-A	2F1	ANL	8,300	5745		5-9-66	6-28-67	UO_2-20PuO_2	7-	23	19.5	6.47	6.15	3.7						
									HOV-4											
									HOV-10											
									HOV-15											
									SOV-1											
									SOV-3											
									SOV-7											
									TVOV-1											

TABLE XXXIV (CON'T)
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SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT		MID-PLANE BURNUP RATES a/o /MWd X 10^4		STATUS AS OF 6/30/68	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68
					MWd					MAX.	MIN.	MAX.	MIN.	%BU(MAX)						NVT X 10^{-22} TOTAL FLUX
X011 (CONT.) MK-A	2F1	GE	8300	5745		5-9-66	6-28-67	UO_2-20PuO_2	9- F4A F4D F4E F4F F4G F4H F4J F4K F4L	17.9	16.4	6.47	6.15	3.7						
		PNWL		5745				PuO_2-S/S	2- 5P-9 5P-12	11.5	7.5	7.52	7.45	4.3						
		PNWL		5745				UO_2-S/S	1- 5U-14	5.9	5.9	6.12		3.5						
X012 MK-A	4B2	NUMEC	20,100		7809	8-10-66		UO_2-20PuO_2	19- C-1 C-2 C-3 C-4 C-6 C-7 C-8 C-9 C-10 C-11 C-12 C-13 C-14 C-15 C-16 C-17 C-18 C-19 D-5	15.5	13.5	6.07	5.38	4.7						
013 K-A	3C1	ANL	1,200	1,309		7-17-66	9-7-66								19- As-34 As-35 As-36	 HAST-X INCO-625 V-20Ti INCO-625 V-20Ti	 X X X	 X X X		0.6

TABLE XXXIV (CON'T)

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SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX.	MIN.	MID-PLANE BURNUP RATES a/o /MWd X10[4] MAX.	MIN.	STATUS AS OF 6/30/68 % BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X013	3C1	ANL	1,200	1,309		7-17-66	9-7-66								As-37	HAST-X	X	X		0.6
MK-A															As-38	V-15Ti				
(CONT.)																7.5CR	X			
																V-20Ti		X		
															As-39	V-15Ti				
																7.5 CR	X			
																V-20Ti		X		
															As-40	V-15Ti				
																7.5 CR	X			
																V-20Ti		X		
															As-41	V-15Ti				
																7.5 CR	X			
																V-20Ti		X		
															As-42	V-15Ti				
																7.5 CR	X	X		
															As-43	V-15Ti				
																7.5 CR	X	X		
															As-44	V-15Ti				
																7.5 CR	X	X		
															As-45	INCO-625	X			
																V-15Ti				
																7.5 CR		X		
															As-46	HAST-X	X	X		
															As-47	304	X	X		
															As-48	304	X	X		
															As-49	304	X	X		
															As-54	V-15Ti				
																7.5 CR	X	X		
															As-55	INCO-625	X			
																V-15Ti				
																7.5 CR		X		
		PNWL		1,309											1-					0.6
															BG-1	GRAPHITE				
X014	4E2	PNWL	No	3,674		7-17-66	4-10-67								5-					1.8
MK-A			Limit												A-9	304		X		
															A-10	348		X		
															A-11	348		X		
															A-12	304		X		
															A-13	304 & 348				

TABLE XXXIV (CON'T)
6/30/68

SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX.	POWER GENERATION KW/FT MIN.	MID-PLANE BURNUP RATES a/o /MWd X 10^4 MAX.	MID-PLANE BURNUP RATES a/o /MWd X 10^4 MIN.	STATUS AS OF 6/30/68 % BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X014		GE		3674		7-17-66	4-10-67								5-					1.8
MK-A															L4A	I-800	X	X		
(CONT.)															L4B	I-800	X	X		
															L4E	347	X	X		
															L4F	304	X	X		
															L4G	321	X	X		
		NRL		3674											5-					1.8
															NRL-1	I-800		X		
																HAST-X		X		
																304,316		X		
															NRL-2	I-800		X		
																316		X		
															NRL-3	I-800				
																304		X		
																316		X		
															NRL-4	I-800				
																304		X		
																316		X		
															NRL-5	INCO-625		X		
																HAST-X				
																316		X		
		PNWL		3674											2-					1.8
															BG-2	GRAPHITE				
															BG-3	GRAPHITE				
		GE		3674											2-					1.8
															MT-5	I-800	X	X		
															MT-6	I-800	X	X		
X015	4A2	NUMEC	11,000		6154	11-15-66		UO_2-20PuO_2	11-	15.4	14.0	6.04	5.55	3.7						
MK-A	4D2					11-22-67			B-1											
	4A2					12-23-67			B-2											
									B-3											
									B-4											
									B-5											
									B-6											
									B-7											
									B-8											
									B-9											
									B-10											
									B-11											
		GE			6154			UO_2-20PuO_2	2-	14.0	14.0	5.55	5.55	3.4						
									F7C											
									F7D											

TABLE XXXIV (CON'T)

6/30/68

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX.	MIN.	MID-PLANE BURNUP RATES a/o /MWd X10^4 MAX.	MIN.	STATUS AS OF 6/30/68 %BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X015 MK-A (CONT.)		ANL	11,000		6154			(U.8PU.2)C	4- NMV-3 TVMV-1 NMV-2 NMP-1	25.0	17.6	6.08	4.10	3.7						
		ANL			6154			MK-IA (METAL)	2- BF02 BF03	7.6	7.6	3.16	3.16	1.9						
X016 MK-B-19	4D3 4F3 4D2	GE	7,400 *		5800	1-13-67 11-22-67 12-23-67									10- L-10-A L-10-B L-10-C L-10-D L-10-E L-10-F L-10-G L-10-H L-10-I L-10-J	 I-800 I-800 I-800 316 316 316 304 304 347 321	 X X X X X X X X X X	 X X X X X X X X X X		2.1
		ANL			5800										9- AS-29 AS-30 AS-31 AS-32 AS-33 AS-50 AS-51 AS-52 AS-53	 304 Vi-Ti-Cr In-625 HAST-X In-625 Vi-Ti-Cr 304 HAST-X HAST-X	 X X X X X X X X X	 X X X X X X X X X		2.1
X017 MK-A	4C3	NuMEC	6,500		6154	11-15-66		UO_2-20PuO_2	11- A1 A2 A3 A4 A5 A6 A7 A8 A9	15.4	13.5	6.04	5.37	3.7						

* Adjusted for Characterized Flux Spectrum

TABLE XXXIV (CON'T)
6/30/68

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX.	FUEL CAPSULES: POWER GENERATION KW/FT MIN.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X10^4 MAX.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X10^4 MIN.	FUEL CAPSULES: STATUS AS OF 6/30/68 %BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	MATERIAL CAPSULES: TYPE OF SAMPLE: BURST TEST	MATERIAL CAPSULES: TYPE OF SAMPLE: TENSILE	MATERIAL CAPSULES: TYPE OF SAMPLE: CREEP RUPTURE	MATERIAL CAPSULES: STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X017 MK-A (CONT.)	4C3		6,500			11-15-66			A10 A11											
		UNC			6154			(U.8 Pu.2)C	3- 87 89 90	26.8	25.2	6.17	5.79	3.8						
		ANL			6154			MK-1A METAL	5- BF04 BF05 BF08 BF09 BF11	8.4	8.2	3.43	3.37	2.1						
X018 MK-B-7	2B1	GE	21,300		6440	12-6-66									3- a b c	 1800,316 304,316 304, 321, 347	 X X X	 ·X X X		2.6
		ANL			6440										3- AS-56 AS-57 AS-58	 V20Ti,V15 Ti-7,5Cr HAST-X 304 V20Ti, V15Tl- 7.5 CR	 X X X	 X X X	 X X X	2.6
		PNWL			6440										1- BNWL 7-1	304,316 321,348		 X	 X	2.6
X019 MK-A	6D2	GE	7,500		5226	1-13-67		UO_2-20PuO_2	7- F8A F8B F8C F8D F8E F8F F8G	8	7	3.60	3.10	1.9						
		UNC			5226			(U.8PU.2)C	3- UNC81 UNC82 UNC83	20	19	4.24	3.92	2.2						

TABLE XXIV (CON'T)

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SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX.	POWER GENERATION KW/FT MIN.	MID-PLANE BURNUP RATES a/o /MWd X 10^4 MAX.	MID-PLANE BURNUP RATES a/o /MWd X 10^4 MIN.	STATUS AS OF 6/30/68 % BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X019 (CONT.) MK-A	6D2	PNWL	7,500		5226	1-13-67									8-					1.4
															A26	304,316 348		X		
															A27	304,316 348		X		
															A28	304, 316 348		X		
															A29	304, 316 348		X		
															A32	304, 316 348		X		
															A33	304, 316 348		X		
															A34	304, 316 348		X		
															A35	304, 316 348		X		
		PNWL			5226										1- BG5	GRAPHITE				1.4
X020 MK-A	6B5	GE	7,500		5226	1-13-67		UO_2-PuO_2	9- F8H F8I F8J F8K F8L F8M F8N F8O F8P	8	7	3.60	3.10	1.9						
		UNC			5226			(U.8Pu.2)C	3- UNC84 UNC85 UNC86	20	19	4.24	3.92	2.2						
		PNWL			5226										4-					1.4
															A14	304,316 348		X		
															A15	304,316 348		X		

TABLE XXXIV (CON'T)

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SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX.	FUEL CAPSULES: POWER GENERATION KW/FT MIN.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X10^4 MAX.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X10^4 MIN.	FUEL CAPSULES: STATUS AS OF 6/30/68 %BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	TYPE OF SAMPLE: BURST TEST	TYPE OF SAMPLE: TENSILE	TYPE OF SAMPLE: CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X020 MK-A (CONT.)	6B5		7,500			1-13-67									A30	304,316 348		X		
															A31	304, 316 348		X		
		PNWL			5226										1- BG9	GRAPHITE				1.4
		ANL			5226										2- AS-59	30u Vi-Ti	X	X		1.4
															AS-60	HAST-X				
																Vi-Ti	X	X		
X021 MK-B-7	2D1	PNWL	21,500		5800	2-25-67									7- BNWL-7-2	304,316,321	X	X		
															7-3	348,INC-X	X	X		
															7-4	INC-600, INC-800	X	X		
															7-5	INC-718	X	X		
															7-6	INC-625	X	X		
															7-7	HAST-X	X	X		
															7-8		X	X		
X022 [illegible]-B-7	7C4	PNWL	5,000	5739		2-26-67	6-16-68								7- BNWL-7-9	304,316, 321	X	X		1.1
															7-10	348,INC-X	X	X		
															7-11	INC-600	X	X		
															7-12	INC-800	X	X		
															7-13	INC-718	X	X		
																HAST-X	X	X		
															7-14	INC-625				
															7-15		X	X		
[illegible]023 [illegible]-B-7	2B1	ORNL	30	33.8		7-21-67	7-23-67								7- ORNL-A	FLUX WIRE				0.01
															-B	SST.,Ni,MO Mo-50RE				
															-C	SST.,Ni,W				
															-D	-HEAT				
															-E	SST.,Ni, W-25RE				
															-F	SST.,Ni, -HEAT				
															-G	SST.,Ni, -HEAT				

TABLE XXXIV (CON'T)
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SUB ASSEMBLY	GRID LOCATION	EXPERIMENTER(S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX.	MIN.	MID-PLANE BURNUP RATES a/o /MWd X10^4 MAX.	MIN.	STATUS AS OF 6/30/68 %BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X024 MK-B-7	7D4	ORNL	30	33.8		7-21-67	7-23-67								7- ONRL-H	FLUX WIRE				0.01
															-I	SST.,Ni -HEAT				
															-J	SST.,Ni -HEAT				
															-K	SST. -HEAT				
															-L	SST.,Ni -HEAT				
															-M	SST.,Ni -HEAT				
															-N	SST.,Ni -HEAT				
X025 MK-B-19	4E2	GE	7400*		4152	10-10-67									19-			.		1.5
															NA	304				
															NC	304				
															NE	316				
															NG	316				
															NJ	321				
															NM	347				
															NL	321				
															NP	INC-800				
															NR	INC-800				
															NB	304				
															ND	304				
															NF	316				
															NI	316				
															NH	316				
															NK	321				
															NN	347				
															NQ	INC-800				
															NS	INC-800				
															NO	347				

* Adjusted for Characterized Flux Spectrum

TABLE XXXIV (CON'T)

6/30/68

SUB ASSEMBLY	GRID LOCATION	EXPERI- MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	NO. OF CAPS & DESIGNATION	POWER GENERATION KW/FT MAX.	MIN.	MID-PLANE BURNUP RATES a/o /MWd X 10^4 MAX.	MIN.	STATUS AS OF 6/30/68 % BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL	TYPE OF SAMPLE: BURST TEST	TENSILE	CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X026 MK-B-7	7D5	NRL	3900	4091		10-11-67	6-16-68								7- B-5 B-2 B-7 B-4 B-1 B-6 B-3	304,304L, 316,316L I-800 INCO-625 HAST-X		X X X X X X X		0.8
X027 MK-A	4B3	GE	7200		2246	11-21-67		UO_2-25PuO_2	18- H-20 H-21 H-22 H-23 H-24 H-25 H-26 H-27 H-28 H-29 H-30 H-31 H-32 H-33 H-34 H-35 H-37 H-38	15.4	13.7	6.1	5.4	1.4						
		PNWL			2246										1- A-40	STRUCT.		X	X	0.8
X028 MK-A	4D3	ANL	9200	1730		11-21-67		U-15Pu-10Zr	15- BA01 BA02 BA03 BA04 BA05 BB01 BC01 BC02 BC03 BD03 BD04 BD05	9.49	6.39	5.8	5.0	1.0						

TABLE XXXIV (CON'T)
6/30/68

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX.	FUEL CAPSULES: POWER GENERATION KW/FT MIN.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X 10^4 MAX.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X 10^4 MIN.	FUEL CAPSULES: STATUS AS OF 6/30/68 %BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	MATERIAL CAPSULES: TYPE OF SAMPLE: BURST TEST	MATERIAL CAPSULES: TYPE OF SAMPLE: TENSILE	MATERIAL CAPSULES: TYPE OF SAMPLE: CREEP RUPTURE	MATERIAL CAPSULES: STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X028 MK-A CONT.)	4D3	ANL	9200	1730				U-15Pu-10Zr	BE01 BE02 BE03											
								U-5Fs	4- BF01 BF06 BF07 BF12			3.16	3.16	0.4						
X029 MK-B-37	4E3	ANL	5100		2202	12-22-67		U-5Fs MK-II	37- 200 201 202 203 205 207 209 212 213 218 219 225 227 230 232 234 237 251 255 258 259 262 263 265 266 267 269 270 275	10.2	8.4	5.93	4.45	1.3						

TABLE XXXIV (CON'T)

6/30/68

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX.	FUEL CAPSULES: POWER GENERATION KW/FT MIN.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o / MWd X 10^4 MAX.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o / MWd X 10^4 MIN.	FUEL CAPSULES: STATUS AS OF 6/30/68 % BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	TYPE OF SAMPLE: BURST TEST	TYPE OF SAMPLE: TENSILE	TYPE OF SAMPLE: CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X034 MK-B-7	2F1	ORNL	13,500		1696	4-13-68									7- A B C D E F G	304,304L, M304, M304L, 316,316L, 347,348, Tenelon, UMCO-50, HS-25, + Refractory metals, Hast-X, Hast-R, Fe-Cr-Al- Y		X X X X X X X		0.7
X035 MK-B-7	7B4	ORNL	40,500		1635	4-13-68									7- H I J K L M N	304,304L, M302, M304L, 316,316L, 347,348, Tenelon, UMCO-50, HS-25, + Refractory metals, Hast-X, Hast-R, Fe-Cr-Al- Y	X X X X X X X			0.3

TABLE XXXIV (CON'T)

6/30/68

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX.	FUEL CAPSULES: POWER GENERATION KW/FT MIN.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X10^{4} MAX.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X10^{4} MIN.	FUEL CAPSULES: STATUS AS OF 6/30/68 % BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	MATERIAL CAPSULES: TYPE OF SAMPLE: BURST TEST	MATERIAL CAPSULES: TYPE OF SAMPLE: TENSILE	MATERIAL CAPSULES: TYPE OF SAMPLE: CREEP RUPTURE	MATERIAL CAPSULES: STATUS AS OF 6/30/68 NVT X 10^{-22} TOTAL FLUX
X037 MK-B-7	7C3	INC	3400		1126	5-8-68									7-					0.2
															I-1	A302B		X		
															I-2	A542		X		
															I-3	HV-80		X		
															I-4			X		
															I-5			X		
															I-6			X		
															I-7			X		
X038 MK-B-7	7C5	INC	16,000		1126	5-7-67									7-			X		0.2
															II-1	A302B		X		
															II-2	A542		X		
															II-3	HV-80		X		
															II-4			X		
															II-5			X		
															II-6			X		
															II-7			X		
X900 MK-B-37	7A4 7E1	ANL	2700		1982	3-20-68 6-25-68									18-	304L Stress Corrosion				0.4

TABLE XXXIV (CON'T)

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Sub Assembly	Grid Location	Experi-menter (s)	Goal Exposure MWd	Final Exposure MWd	Status as of 6/30/68 MWd	Date Installed	Date Removed	Fuel Capsules: Fuel	Fuel Capsules: No. of Caps & Designation	Power Generation KW/FT Max.	Power Generation KW/FT Min.	Mid-Plane Burnup Rates a/o /MWd X 10^4 Max.	Mid-Plane Burnup Rates a/o /MWd X 10^4 Min.	Status as of 6/30/68 %BU(MAX)	Material Capsules: No of Caps & Designation	Material	Type of Sample: Burst Test	Type of Sample: Tensile	Type of Sample: Creep Rupture	Status as of 6/30/68 NVT X 10^{-22} Total Flux
X034 MK-B-7	2F1	ORNL	13,500		1696	4-13-68									7- A B C D E F G	304, 304L, M304, M304L, 316, 316L, 347, 348, Tenelon, UMCO-50, HS-25, + Refractory metals, Hast-X, Hast-R, Fe-Cr-Al- Y		X X X X X X X		0.7
X035 MK-B-7	7B4	ORNL	40,500		1635	4-13-68									7- H I J K L M N	304, 304L, M302, M304L, 316, 316L, 347, 348, Tenelon, UMCO-50, HS-25, + Refractory metals, Hast-X, Hast-R, Fe-Cr-Al- Y	X X X X X X X			0.3

TABLE XXXIV (CON'T)

6/30/68

SUB ASSEMBLY	GRID LOCATION	EXPERI-MENTER (S)	GOAL EXPOSURE MWd	FINAL EXPOSURE MWd	STATUS AS OF 6/30/68 MWd	DATE INSTALLED	DATE REMOVED	FUEL CAPSULES: FUEL	FUEL CAPSULES: NO. OF CAPS & DESIGNATION	FUEL CAPSULES: POWER GENERATION KW/FT MAX.	FUEL CAPSULES: POWER GENERATION KW/FT MIN.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X 10^4 MAX.	FUEL CAPSULES: MID-PLANE BURNUP RATES a/o /MWd X 10^4 MIN.	FUEL CAPSULES: STATUS AS OF 6/30/68 % BU(MAX)	MATERIAL CAPSULES: NO OF CAPS & DESIGNATION	MATERIAL CAPSULES: MATERIAL	TYPE OF SAMPLE: BURST TEST	TYPE OF SAMPLE: TENSILE	TYPE OF SAMPLE: CREEP RUPTURE	STATUS AS OF 6/30/68 NVT X 10^{22} TOTAL FLUX
X037 MK-B-7	7C3	INC	3400		1126	5-8-68									7-					0.2
															I-1	A302B		X		
															I-2	A542		X		
															I-3	HV-80		X		
															I-4			X		
															I-5			X		
															I-6			X		
															I-7			X		
X038 MK-B-7	7C5	INC	16,000		1126	5-7-67									7-			X		0.2
															II-1	A302B		X		
															II-2	A542		X		
															II-3	HV-80		X		
															II-4			X		
															II-5			X		
															II-6			X		
															II-7			X		
X900 MK-B-37	7A4 7E1	ANL	2700		1982	3-20-68 6-25-68									18-	304L Stress Corrosion				0.4

2. Primary Sodium Purification System (continued)

To aid in "trouble-shooting" the surge-tank vacuum and argon-supply systems, a vacuum gauge was installed between the two argon-gas syphon-break valves. This guage will provide a means for determining the leak rate through the motorized, bellows-sealed gate valve (reference Standard Maintenance Procedure No. 12).

The throttle valve bellows of the plugging indicator failed. The system was shut down and a rebuilt spare valve installed in accordance with Standard Maintenance Procedure No. 25.

3. Fuel Unloading Machine

The drip catcher was cleaned several times and the rotating port was cleaned twice. New "O" rings were installed once.

4. FUM Argon Cooling System

The vapor trap for the FUM argon cooling system was replaced twice with a new unit. The plugged unit was cleaned and new mesh was installed.

The subassembly heater burned out and a new heater was installed. The system pressure-gauge panel was lowered to provide access for the new cable tray that is being installed as part of Plant Modification No. 148.

Air in-leakage in the FUM argon system was reported when the No. 1 interbuilding coffin (IBC) was used for fuel transfers. The Fuel Cycle Facility was notified so that a leak-rate test could be run on the No. 1 IBC. In addition, the coupling connections from the No. 1 IBC to the argon system were checked for tightness, and the seat in valve "L" was replaced.

5. Primary-Tank "W" Heaters

The W-4 heater was reconnected to the power supply after replacement of a burned-out heating element. The elements were meggered and checked out at 3.4 to 5.0 megohms.

A reported argon gas leak in W-2 heater, resulted in discovery of a burned-out heating element. Attempts to stop the gas leakage have not been successful. Apparently the leakage is through a hole burned in the heater jacket. Replacement of the element should stop the leakage, and a new element will be installed when plant conditions permit.

6. Transfer Arm

The clutch and handle for vertical movement of the transfer arm were reworked. The clutch had been welded to make it a direct-drive unit. The clutch was reworked, and set to limit the force that can be

6. Transfer Arm (continued)

applied to 100 lb. The handle attachment has been reworked into a heavier-duty unit to prevent shearing of the linkage bolts. The shearing has been a recurring problem.

7. Fission Gas Monitor (FGM)

A modified wire drive was installed (Plant Modification No. 191). This modification consisted of replacing the O-ring belt drive with a chain and sprockets.

The level-wind drive motor for the FGM take-up spool was replaced because of stripped gears in the original unit.

Travel switches were adjusted on the wire level-wind reel to correct a wire knotting problem.

A leak developed in the diaphragm of the FGM pump. A new spare pump was installed as a replacement.

8. Fuel Element Rupture Detector (FERD) Loop

New angle drives are being installed on the sample station valves in the FERD loop. This will provide means for operating the valves in an easily accessible location.

9. Reactor Cover Lock No. 3

Disassembly of the gear-box housing for replacement of an oil seal was started. Several of the bolts were found to be badly galled and disassembly was stopped until a longer shutdown could be scheduled. The bolts that were removed because of galling were discarded and new bolts were fabricated from "stress-proof" material. The threads in the bolt holes were dressed and the new bolts installed. Galling of the bolts was apparently due to set screws that locked into the bolt threads. The set screws were removed prior to attempting removal of the bolts, but the bolt threads were already damaged.

10. Reactor-Building Freight Door

The annual leak-rate test on the reactor-building freight door was satisfactorily completed. The leak rate was 1.8 ft^3/24 hours (32°F, 36.2 psia).

11. Control-Rod Mechanical Interlocks

The No. 3 control-rod mechanical interlock was repaired. Later, the mechanical platform interlocks on control-rod drives Nos. 3 and 9 were damaged. Both interlocks were rebuilt.

12. Mark-II Oscillator Rod

The oscillator rod and drive assembly were removed after sodium was found in the tube above the bellows. A new spare control rod was installed in its place.

13. Small Steam By-Pass Valve VC-501-B

Because of failure of this valve, the cage assembly was sent to Salt Lake City for inspection by the vendor. The vendor recommended that the cage assembly material should be changed from stainless steel to solid stellite. The new stellite cage assembly was received, assembled, and operationally checked.

14. Power-Plant General Maintenance

a. Control valves P5-VC-620, P5-VC-598A, and P5-VC-609 were repaired and returned to service.

b. A new flange gasket was installed in PS-311A.

c. The seat and disk on P3-SV-676 was reconditioned.

d. PF-28 was replaced with a new valve.

e. The thrust bearing on the motor-driven feedwater pump was inspected.

f. A number of steam traps were repaired and minor valves were repacked.

15. Power-Plant Flanges

Visual inspection of all steam-system and feedwater-system flanges was started. Any flanges that appear to have compressed-asbestos gaskets for seals will be changed as plant conditions permit. All flanges inspected have been given a designation and noted as to type of gasket.

16. Startup Feedwater Pump

The No. 1 and No. 3 suction valves on this pump were disassembled and cleaned and new O-rings were installed. The No. 2 cylinder plunger was repacked after 235 hours of running time on the old packing. This is a major improvement for this pump. The relief valve for the startup feedwater pump developed a leak past the seat. The valve was disassembled and the seat and disk were refinished.

17. Turbine Feedwater Pump

Both flexitallic gaskets in the throttle stop valve of the turbine-driven feedwater pump were replaced. The casing drain valves on the feedwater pump were relocated and replaced with new valves. Difficulties

17. Turbine Feedwater Pump (continued)

were encountered in the removal of the pump drain valve. The connecting piping to the valve had to be cut off, and a new welded nipple and valve assembly was installed.

During operation of the pump, the manual trip plunger came off, causing oil to be thrown out of the pump oil system. The plunger spring and spring retainer were modified by installing a roll pin. This should prevent future loss of the spring.

18. Turbine-Generator Hydrogen System

The 10-lb regulator on the hydrogen manifold reducing station was replaced with a model 40-M regulator.

19. Feedwater Heater

a. Heater No. 2

Gaskets on the spray nozzles for the No. 2 heater were replaced after machining of the flanges in the machine shop. The units were pressurized, leak checked, and placed in service.

b. Heater No. 4

A steam leak developed in a flange on the level control for No. 4 heater. The leak was repaired by installing a flexitallic gasket as a replacement for the original asbestos gasket.

The upper gauge glass valve on No. 4 heater was repacked.

20. Turbine-Driven Condensate Pump

The outboard bearing on the turbine for the condensate pump was reported to be running hot. The bearing was inspected and found to be in excellent condition. The overheating was probably caused by excessive leakage past the shaft seal-rings. New rings were installed and no further difficulties have been encountered.

21. Acid Eductor System

An eductor and tubing system was installed to inject acid from carboys into the cooling-tower suction bay.

22. Main Turbine-Generator Exciter

A terminal burned off in the generator-field loss-of-current relay, causing the turbine to trip off the line. The apparent cause of the failure was a connection that became loose because of a breakdown of the mounting board. The terminal has been reworked to provide direct connections that will not depend on the mounting board for maintaining tightness.

22. Main Turbine-Generator Exciter (continued)

During electrical checks required by this failure, a low-resistance reading was detected on the exciter-armature output leads. The exciter was partially disassembled for inspection and cleaning. The low resistance was traced to a deposition of carbon on the brush-holder insulators on the exciter armature.

The bus bars in the exciter were reinsulated and the pole pieces were removed and cleaned. The unit was reassembled and has been placed in operation.

The commutator on the main generator exciter was inspected and cleaned. Four brushes were removed in order to bring the current density closer to the manufacturer's recommendations.

23. Primary M-G Set Exciters

The coupling-end motor bearing for the No. 1 primary M-G set was inspected. Some streaking of the shaft was found, but the bearing appeared to be in good condition.

An inspection of the exciter commutators was conducted. The commutators were cleaned and new brushes installed.

24. Secondary-Sodium Surge Tank

After installation of an argon "bleed-off" line (in accordance with Plant Modification No. 194) it was found that sodium vapor caused plugging in the flow indicator. Because of this plugging, a vapor trap was fabricated, and was installed between the flow indicator and the system tap-off point.

Subsequent plugging of the vapor trap caused loss of flow. The trap was heated and the plugging cleared. A permanent heating arrangement will be provided to improve the performance of this system.

25. Secondary-Sodium-System Chromatograph

An air leak in the argon system leading to the gas chromatograph was found. This leak was located in the nozzle flange on the surge tank. A temporary repair was made by sealing the flange joint with "RTV" sealing compound.

26. Secondary Dowtherm System

The Dowtherm was drained from the secondary Dowtherm system and new Dowtherm was used to refill the system. Dow Chemical Company had recommended that the Dowtherm be changed. Lab analysis of the old Dowtherm indicated the fluid was not within specifications.

27. <u>480-Volt Emergency Power System</u>

During a power outage, the 400-kW diesel generator breaker did not "closein" properly. Two tests of the system were conducted but there was no evidence of a malfunction. During the testing, a shunt trip coil for the R-1B manual-feeder disconnect switch burned out, and it will be replaced. This coil, however, was not related to the original 400-kW breaker malfunction.

28. <u>480-Volt Main Switchgear</u>

The breaker for the primary-tank immersion heaters (cubicle 5-C) malfunctioned and would not "closein". The breaker was removed and checked on the test stand but would not repeat the malfunction. The breaker was cleaned and reinstalled.

B. <u>Instrumentation and Control</u>

1. <u>Primary Coolant Pump Controls</u>

While power was being leveled at 30 MWt early in April, a reactor scram was caused by low-reference voltage for the clutch for the No. 2 primary-pump M-G set. The Sola voltage regulator for the control circuit was changed because of a suspected malfunction. After a similar scram occurred at 10 MWt following reactor restart, a wire with burned insulation was found on the regulated-reference-voltage terminal strip. The wire had apparently been shorting intermittently to an adjacent connector and was the probable cause of these scrams. The wire was replaced and the reactor was made critical.

2. <u>Nuclear Instrumentation</u>

A series of trips was experienced during fuel reloading, with channel No. 3 (a pulse channel) initiating the trips. The problems were identified as (a) a ground in the system, and (b) preamplifier and cable problems in thimble J2.

The ground was found in thimble O4 on the signal cable for nuclear channel No. 9. The thimble insert was removed and the cables replaced. The cables for channel No. 9 were found damaged by radiation. These cables are standard RG/149U PVC-jacket coax cables. Operation in the high gamma field damages the PVC-jacket and eventually the jacket deteriorates, exposing the shield and the shield grounds.

The RG/149U cable has been replaced with an Amphenol No. 421-010 (mechanical equivalent to RG/115A/U). The No. 421-010 cable has been exposed to a radiation dose rate of 1×10^8 R/hr.

2. Nuclear Instrumentation (continued)

The connectors of the detector (a compensated ion chamber) appeared to be damaged also, but because of the radiation level, a close examination was not possible. Rather than compromise reactor operation, this detector was replaced with a new detector.

The preamplifier and cable problem encountered with channel No. 3 is a continuing problem which will be corrected when approval is received for the installation of the new solid-state equipment.

3. Nuclear System Voltage Regulator

The output section of the voltage regulator for nuclear channels Nos. 1, 4, 7, and 9 failed. The regulator was bypassed for three days until spare parts were available. Repairs were made and the unit placed back in service.

4. Reactor Delta-Temperature Digital Readout

The mechanical register and slide-wire assembly failed on the digital readout for reactor delta temperature. This unit had been scheduled for replacement at a later date. Because of the early failure, the replacement unit was installed ahead of schedule. The new unit is a static voltmeter using backlighted numerals, and integrated circuitry for analog-to-digital conversion. The old unit will be repaired and used elsewhere in the system where reliability is not a must.

5. Temperature Compensation in Total-Flow Instrumentation

A reactor scram occurred following a momentary drop in reactor coolant total flow. The circuit terminations were thoroughly checked for a loose or grounded terminal. No loose terminations were found. The temperature-compensating slide-wire was checked visually and no fault was found. A wiring harness containing leads between the slide-wire assembly and the recorder terminal block is flexed each time the recorder is inspected. This inspection occurs a minimum of once each 8-hour shift. Because of the number of times the harness is flexed, the wiring harness is a suspect in having caused the reactor trip. The total-flow instrumentation was placed back in service without automatic temperature compensation. For the balance of this run, the flow will be manually compensated.

6. Primary-Coolant-Flow System

During Run 27 it was noted that the primary pump speed was down in rpm from that previously indicated for 100% flow. To check for this deficiency, the EM flowmeters were intercalibrated against the Foster flow tube installed in the outlet piping. The flowmeters matched the Foster flow tube and previous intercalibrations within ± 1%.

7. Primary Flow Monitoring Equipment

Following a series of incidents, traceable to vacuum tube failures, with the primary-coolant-flow monitoring equipment, the vacuum-tube-type millivolt-to-milliamp (MV/I) converters were removed and replaced by static converters. The quality of vacuum tubes available from the various manufacturers no longer appears to be as high as in the past. Vacuum tubes formerly acceptable for 5000 to 8000 hours of operation are now failing with as few as 1500 hours of operation.

The installation of the static converters had been scheduled for early in F.Y. 1969 as part of the console modification.

8. Reactor Delta-Temperature Instrumentation

The reactor delta-temperature monitoring system has been subject to drift (0.5 to 1.5°F). The source of the drift has been identified with two signal-conditioning amplifiers for the hot- and cold-leg temperatures employed in summing for delta temperature. By replacing the amplifier for the hot-leg temperature input to the system, a slide-wire and the signal-conditioning amplifiers can be eliminated. This change in equipment will also reduce the noise in the system. The design of the replacement equipment isolates the input from the output, thereby filtering the input noise from the output circuits.

9. Blanket Gas Monitor

The blanket-gas monitoring equipment was received, shop-tested, and installed on a temporary basis to check the response to a fission-product gas release. The release of May 6, 1968, at 0530, was detected with the following results: (a) the Xe-135 trace indicated saturation after increasing by a factor of 40, (b) the Xe-133 increased by a factor of 25, and (c) the A-41 increased by a factor of 15. In all cases, the increase was significant and readily readable on the strip-chart recorder. Permanent installation is now in progress.

10. Shield Cooling System

The control system for the refrigeration compressors and the solenoid-operated valves has been redesigned for additional circuit protection and isolation by fusing each of the individual solenoid valves and by the installation of a separate control transformer for the refrigeration compressor controls.

11. Fuel Handling System

Following an operational problem during which one of the three cover locks failed to torque properly, a protective circuit was added to the cover-lock motor-control circuit to automatically de-energize the motors prior to motor damage. The circuit also prevents restarting until a check has been made of the locks.

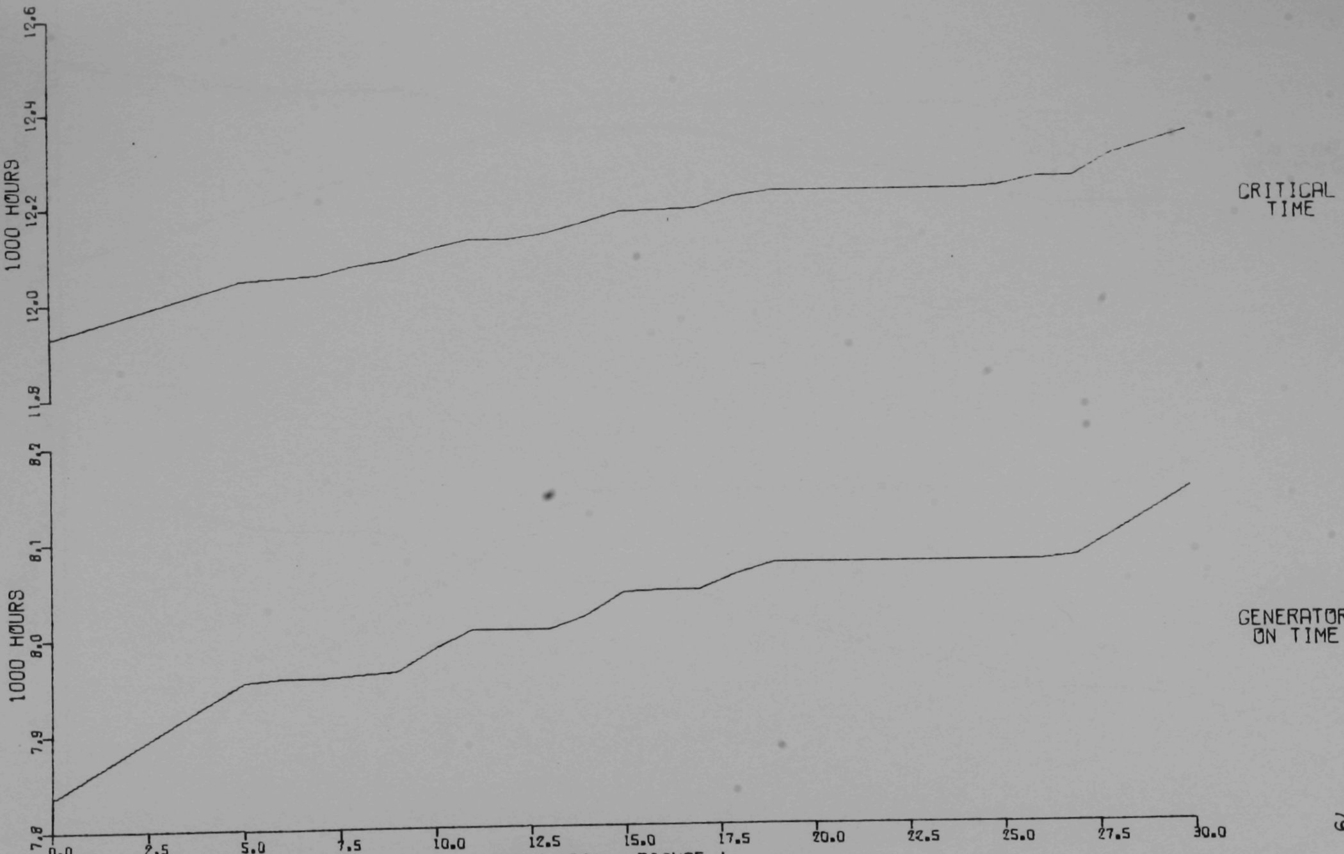
12. Secondary-System Surge-Tank Level

A bearing failed in the motor for the system that supplies coolant air to the power supply for the surge-tank level probes. Temporary cooling was furnished to the power supply until the test program in progress could be completed and the reactor power reduced.

A new motor was installed for continuation of reactor operation. The power supply for the level probes must be relocated to an area of lower ambient temperature if satisfactory operation is to be obtained.

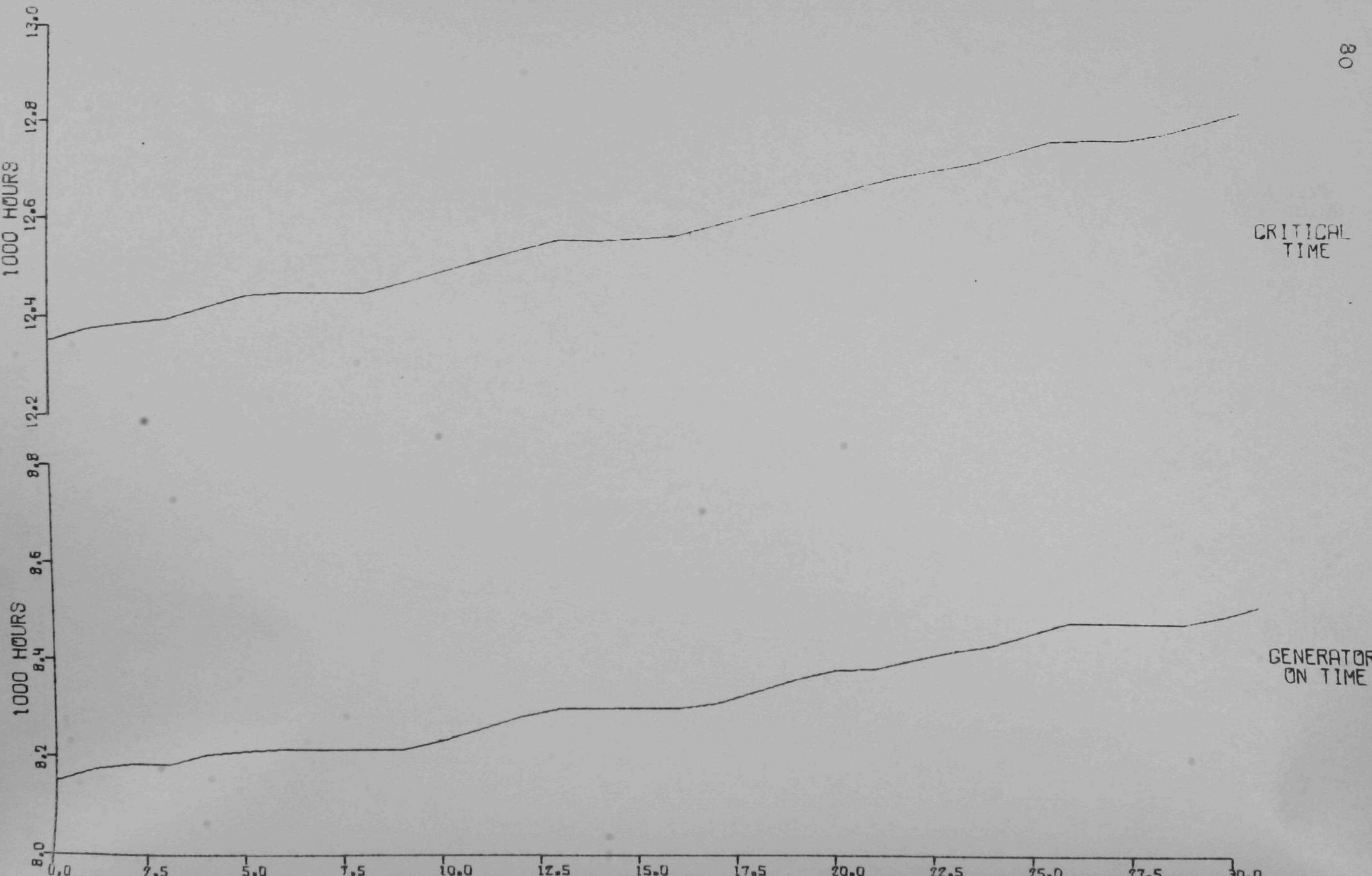
13. Constant-Power Batteries

The batteries in the constant-power battery bank were cleaned and filled and the electrolyte was checked.



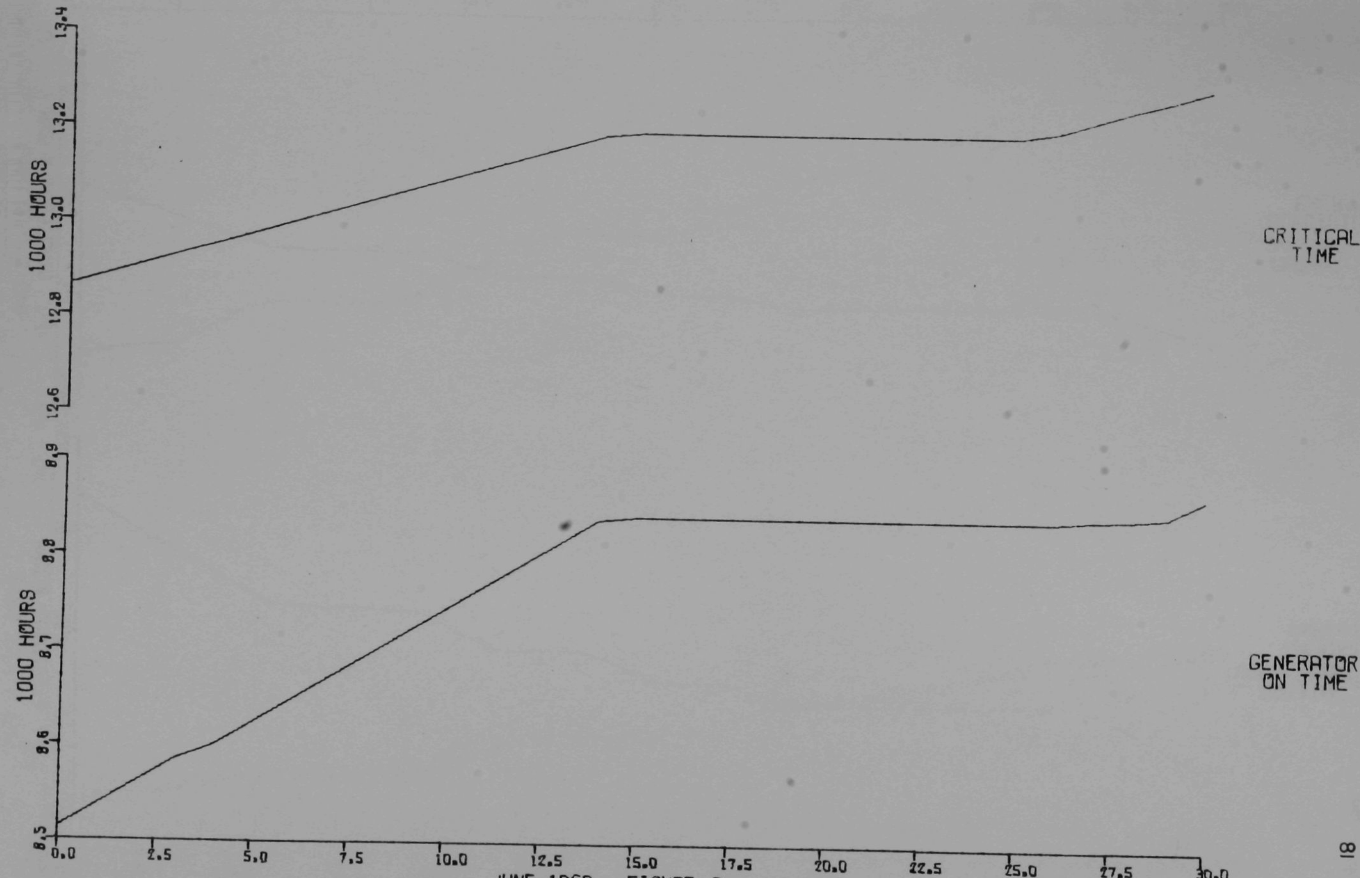
APRIL 1968 FIGURE 1

CUMULATIVE CRITICAL TIME AND GENERATOR ON TIME



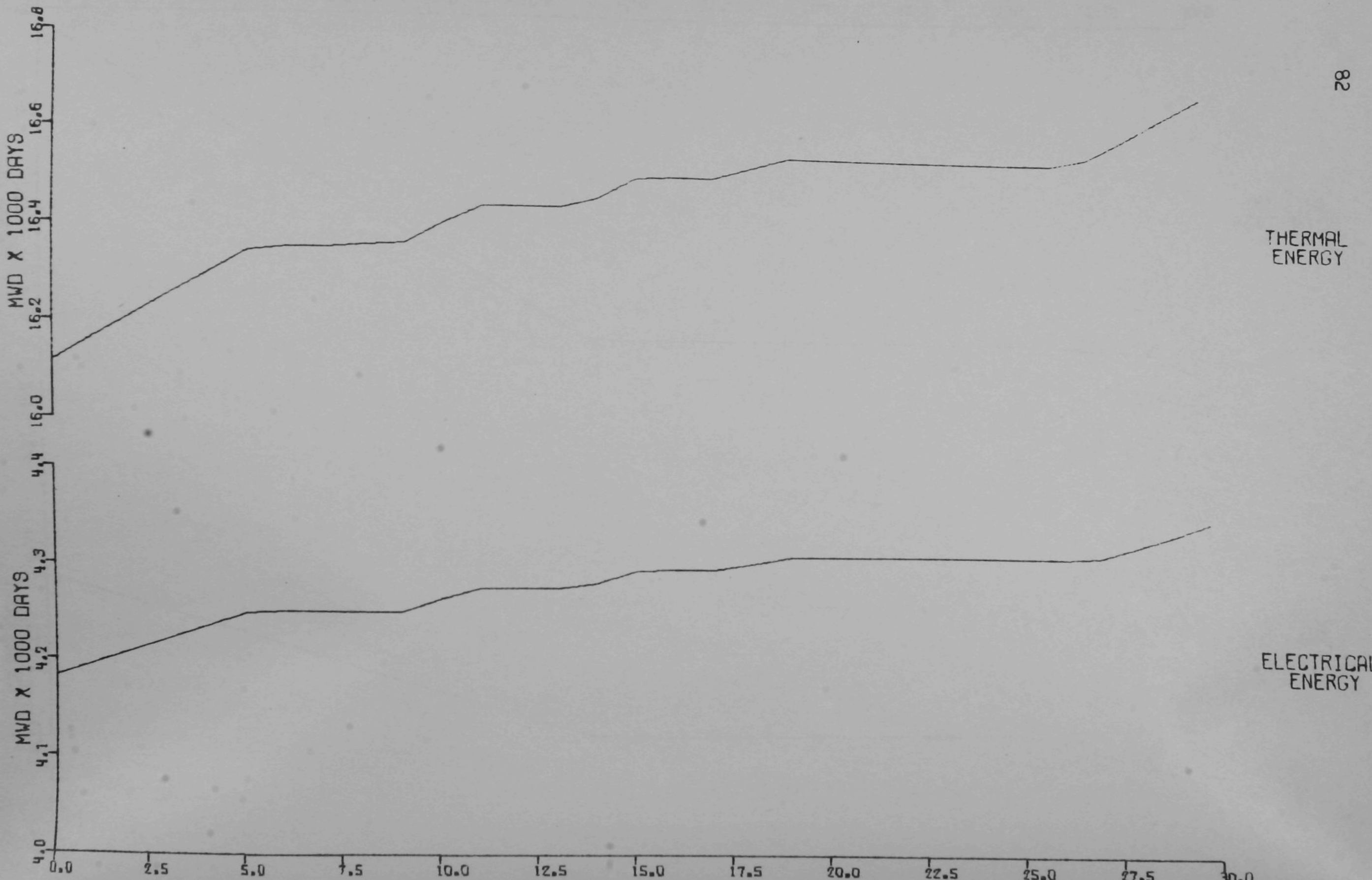
MAY 1968 FIGURE 2

CUMULATIVE CRITICAL TIME AND GENERATOR ON TIME



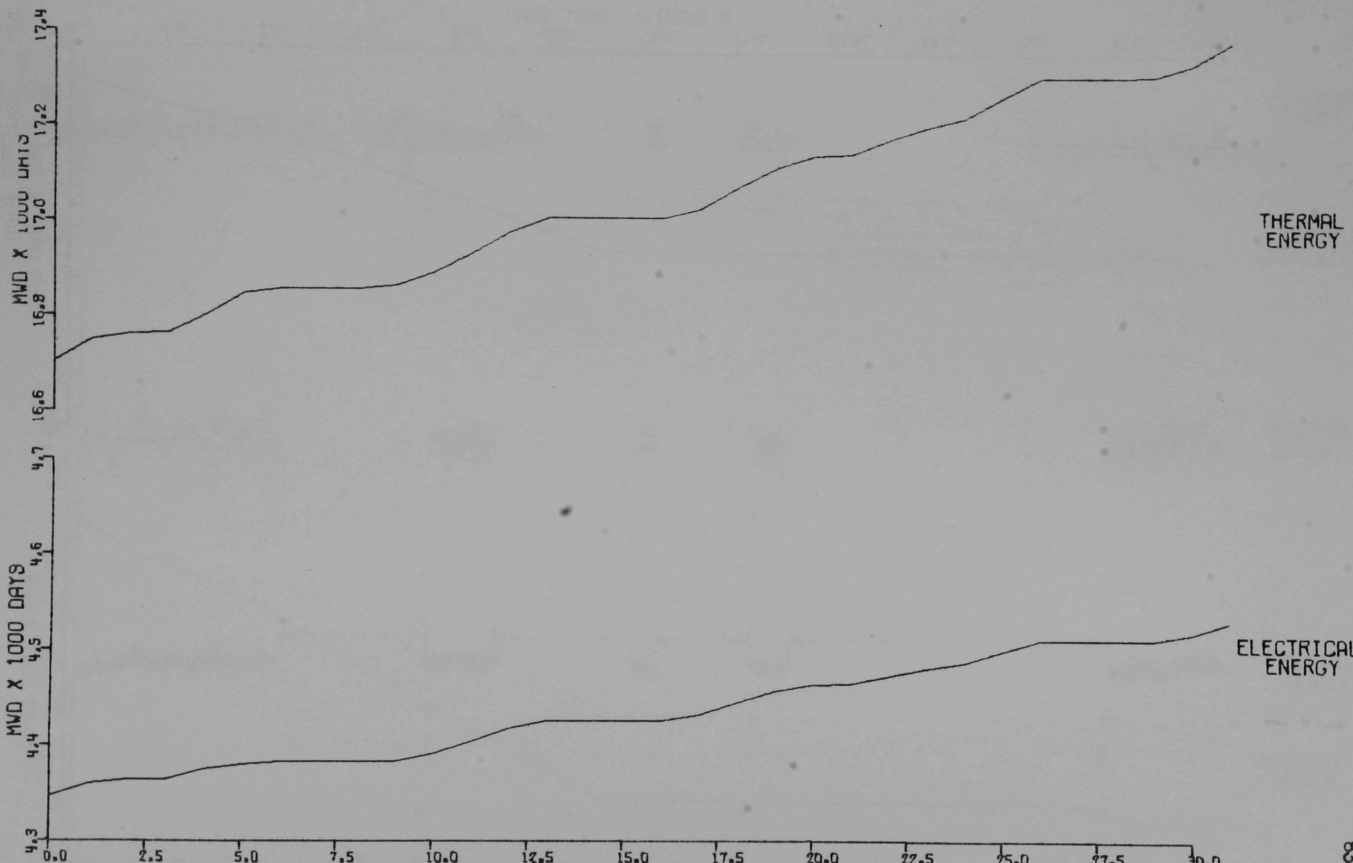
JUNE 1968 FIGURE 3

CUMULATIVE CRITICAL TIME AND GENERATOR ON TIME



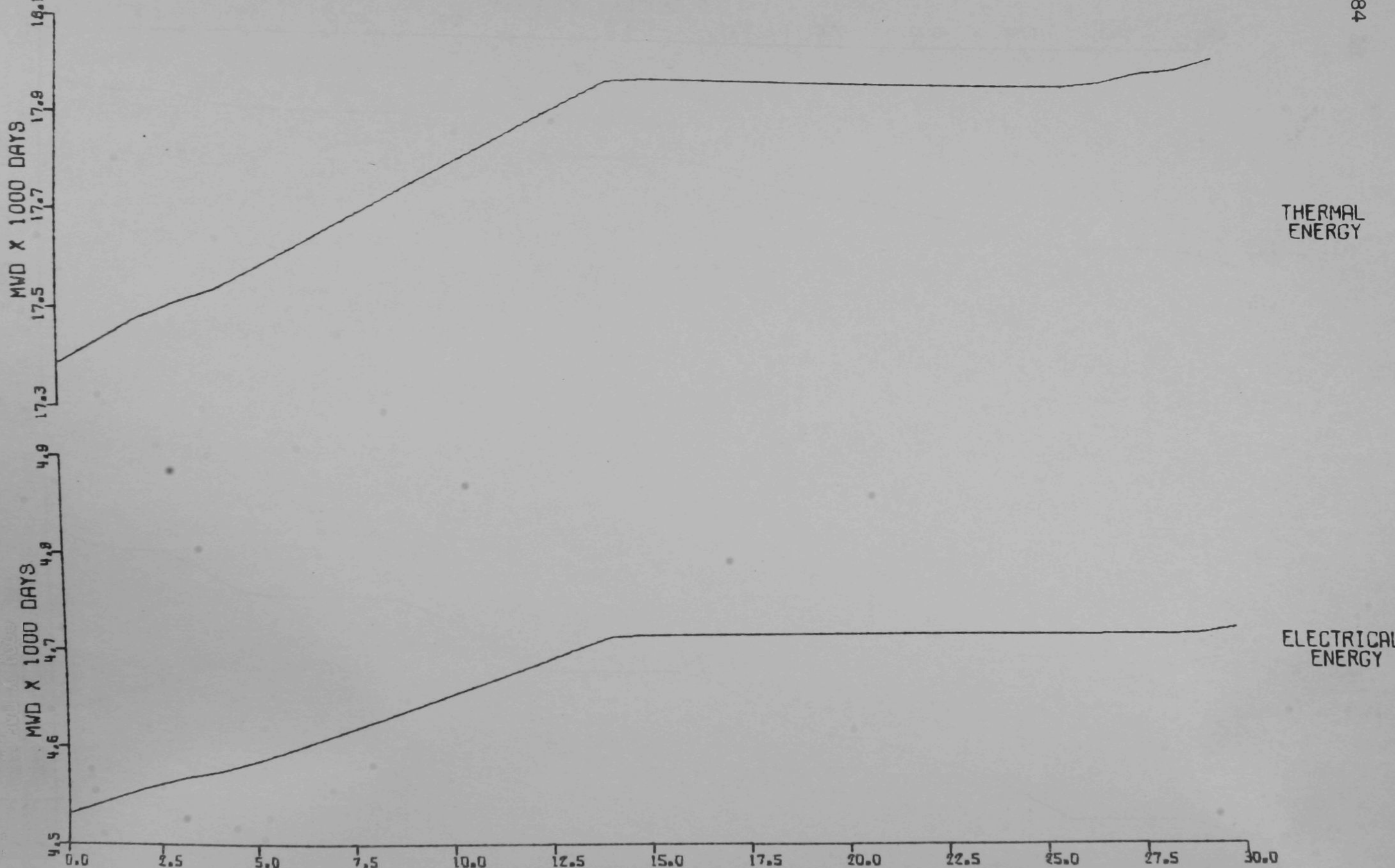
APRIL 1968 FIGURE 4

CUMULATIVE THERMAL AND ELECTRICAL ENERGY



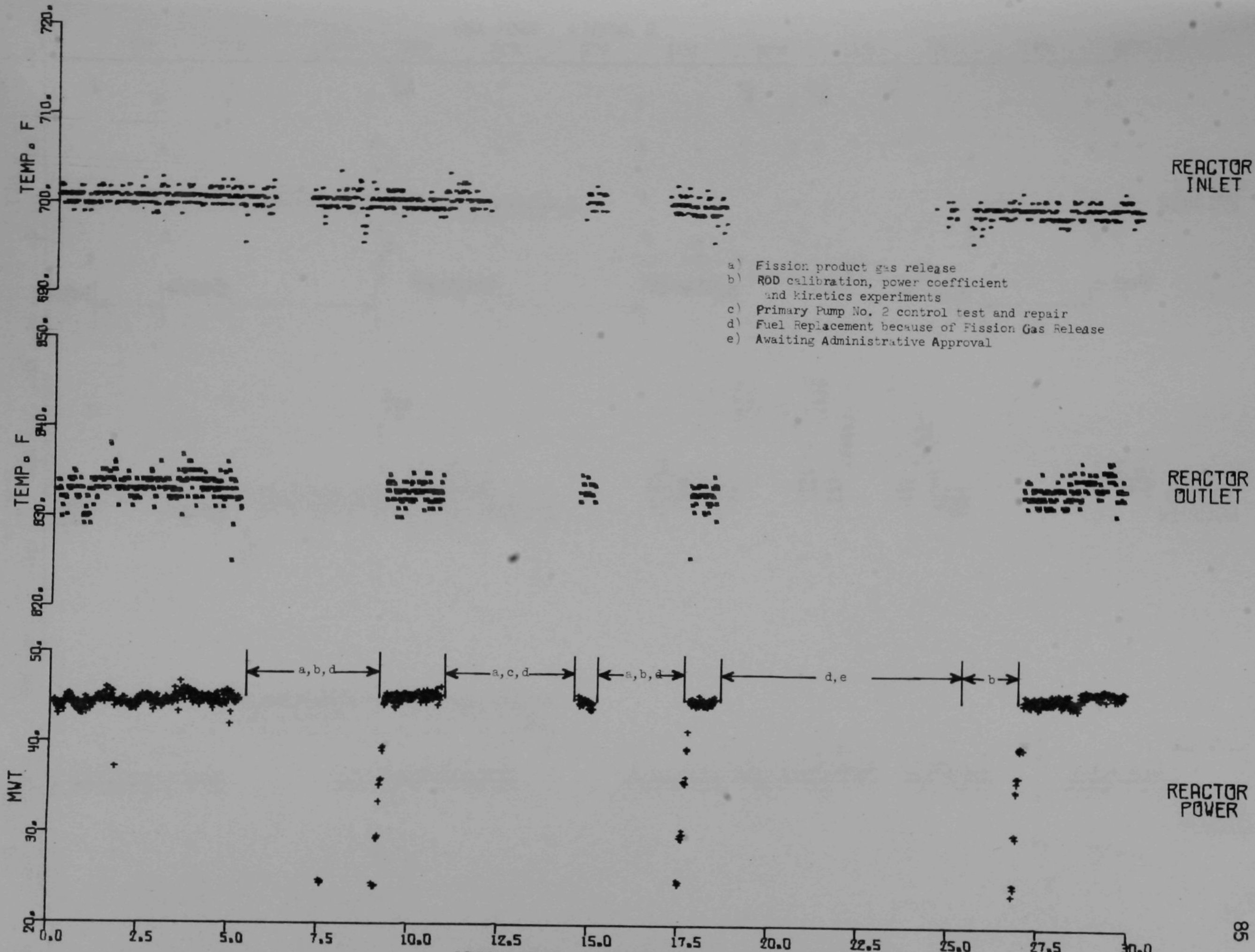
MAY 1968 FIGURE 5

CUMULATIVE THERMAL AND ELECTRICAL ENERGY

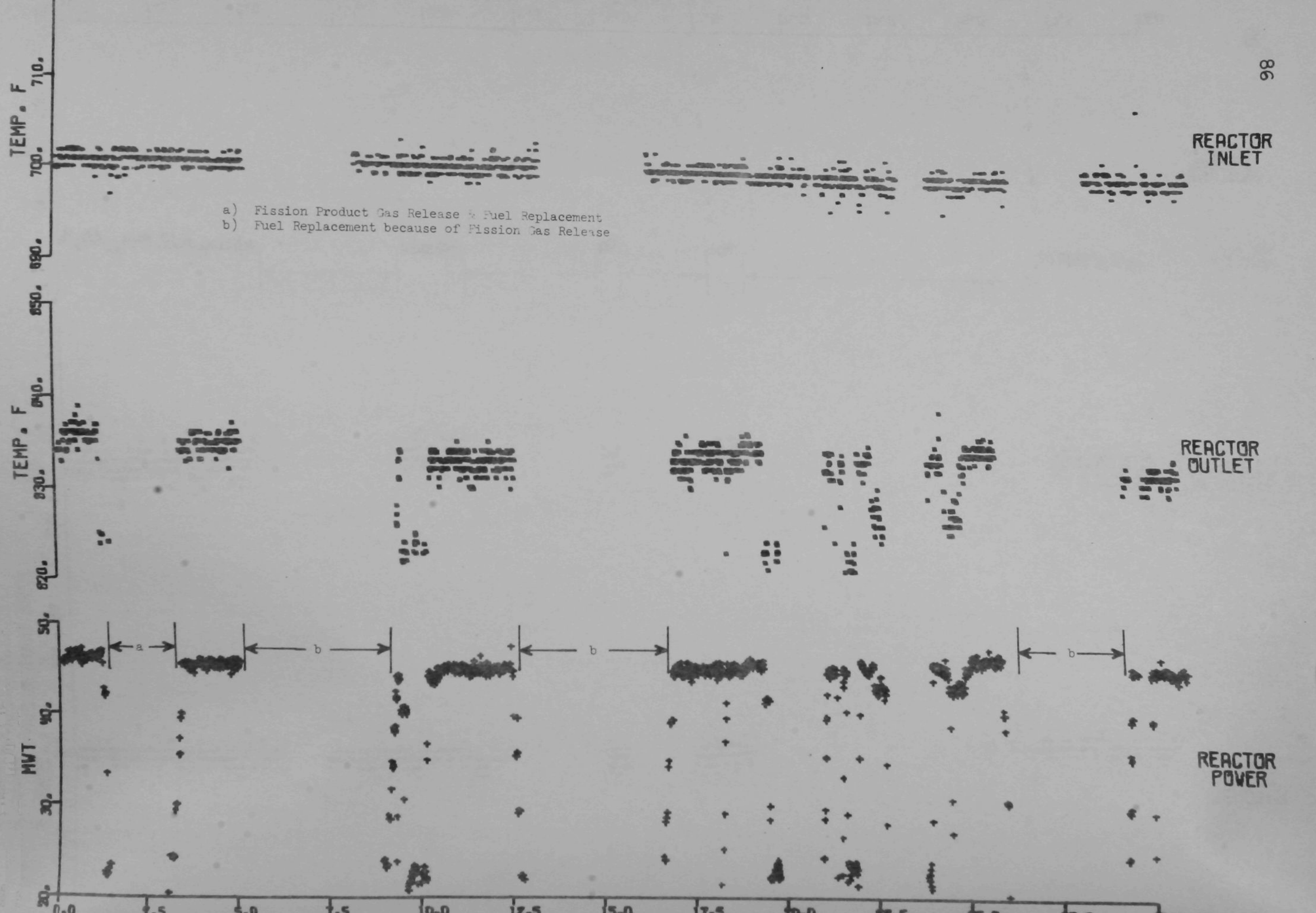


JUNE 1968 FIGURE 6

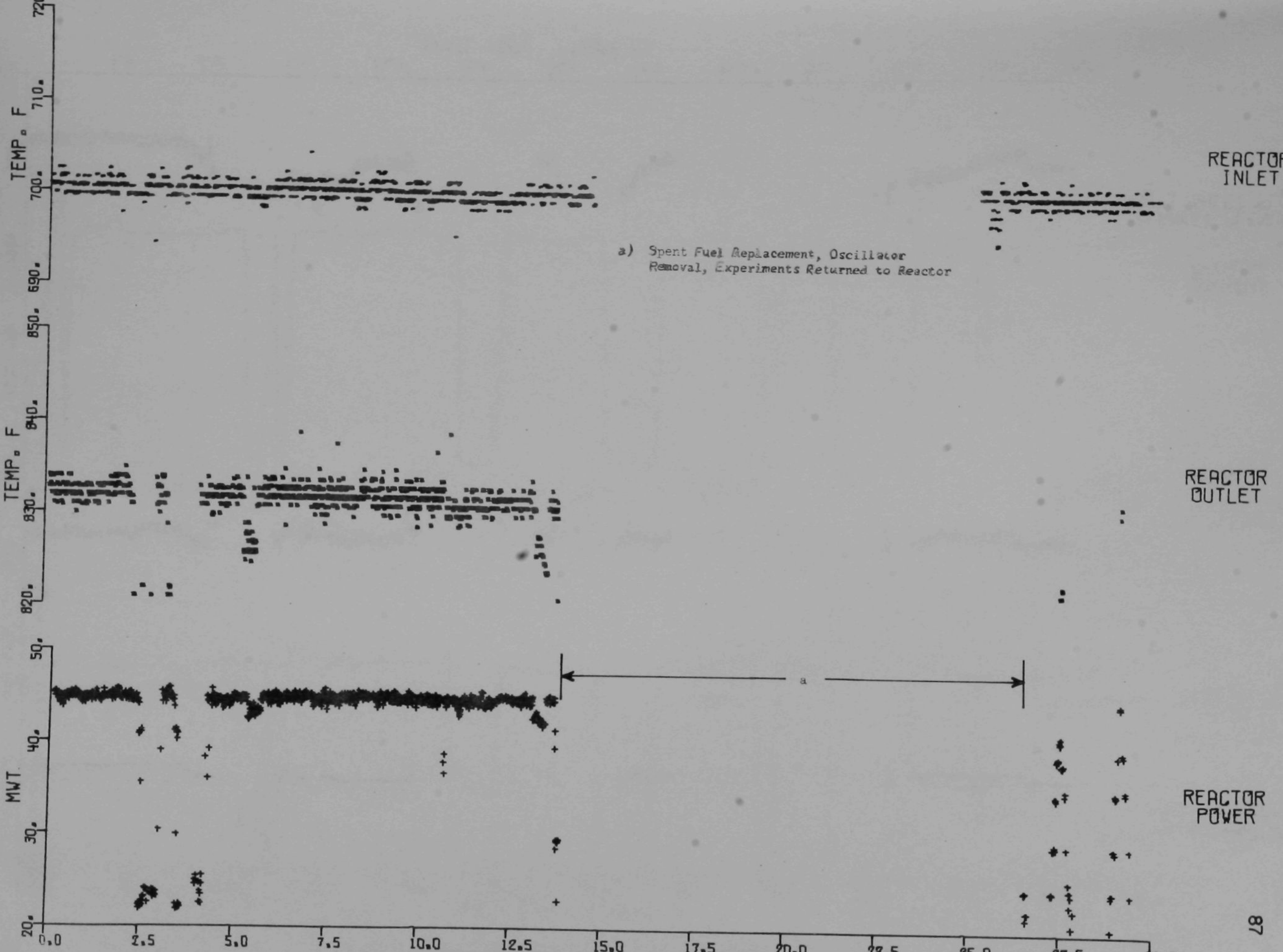
CUMULATIVE THERMAL AND ELECTRICAL ENERGY



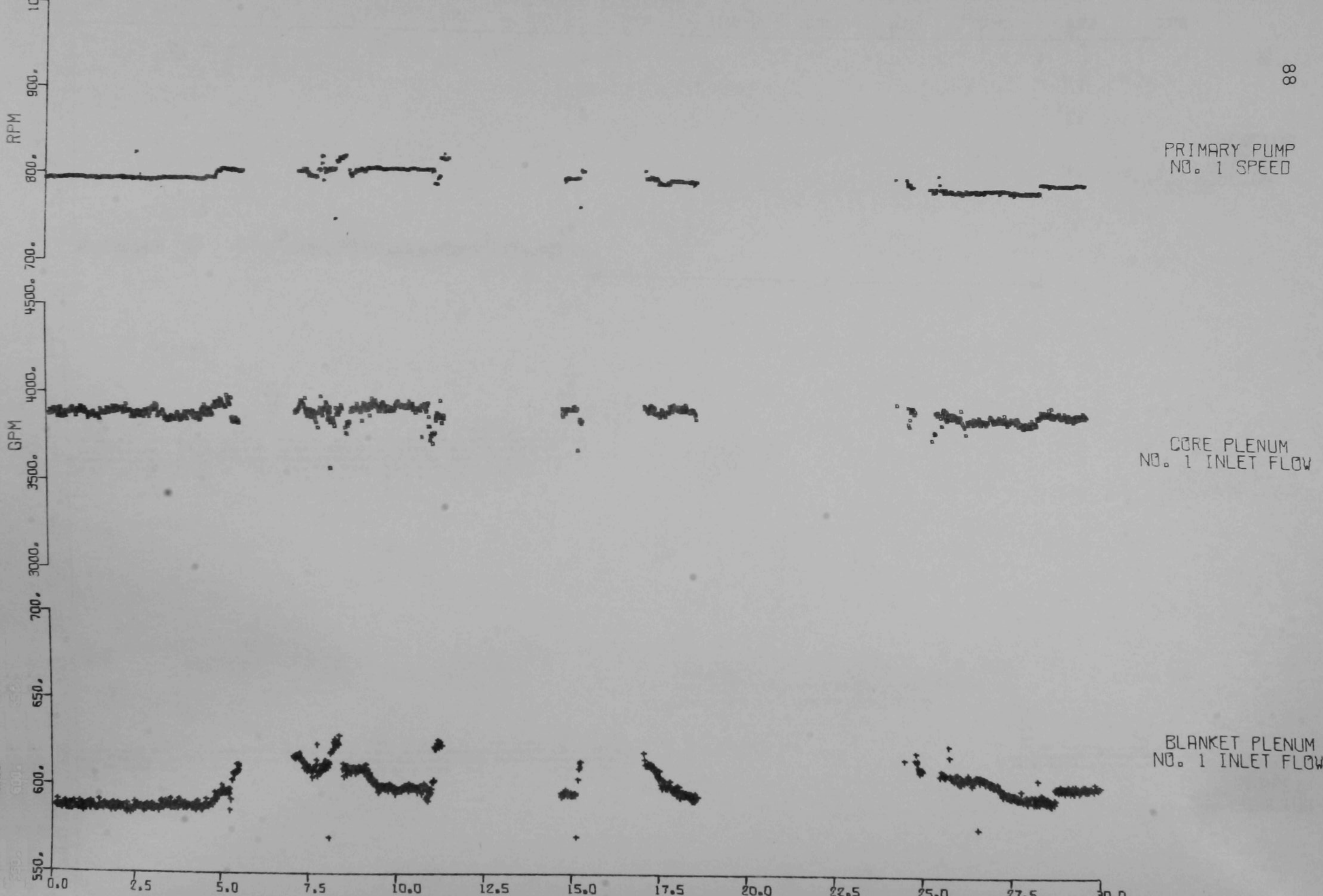
APRIL 1968 FIGURE 7



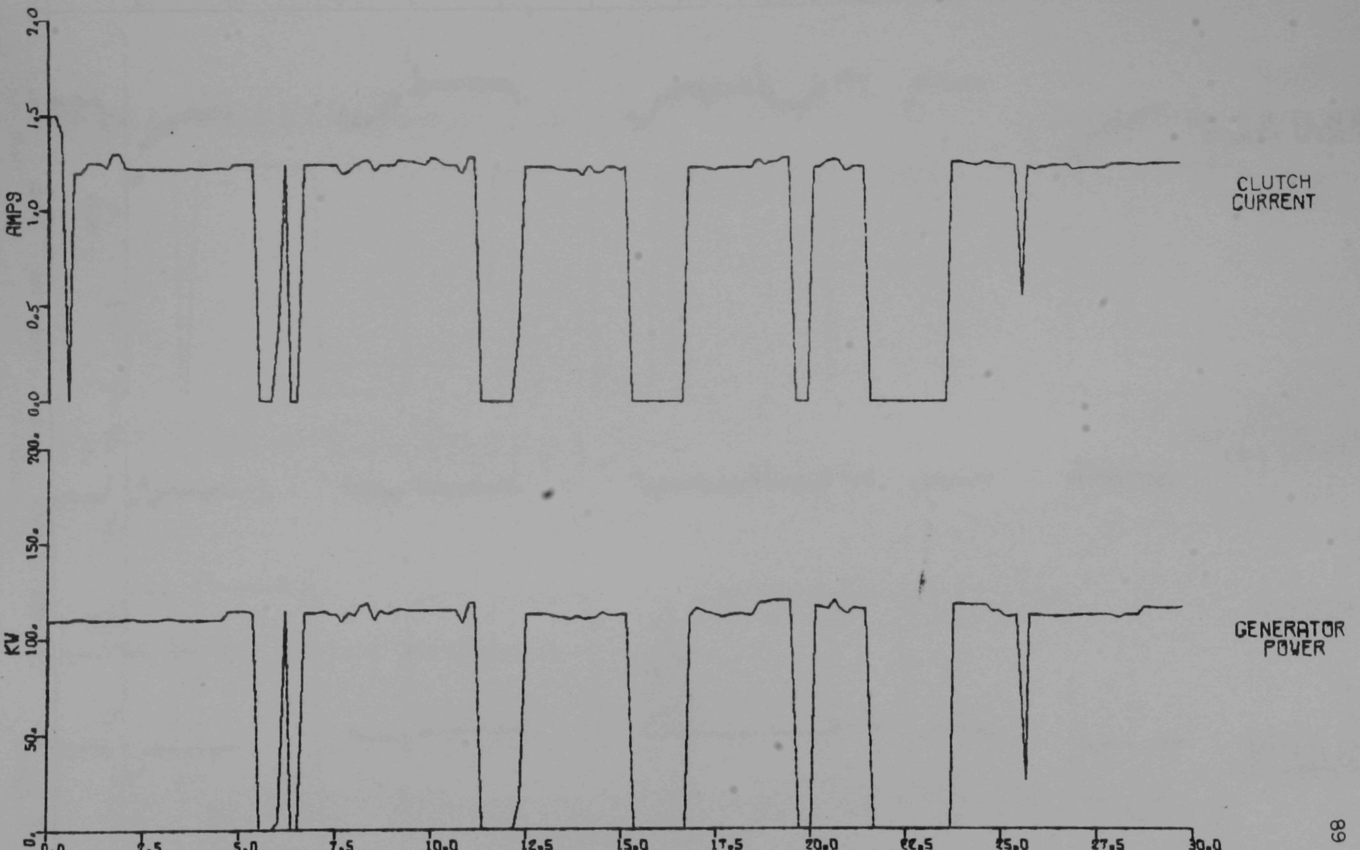
MAY 1968 FIGURE 8



JUNE 1968 FIGURE 9

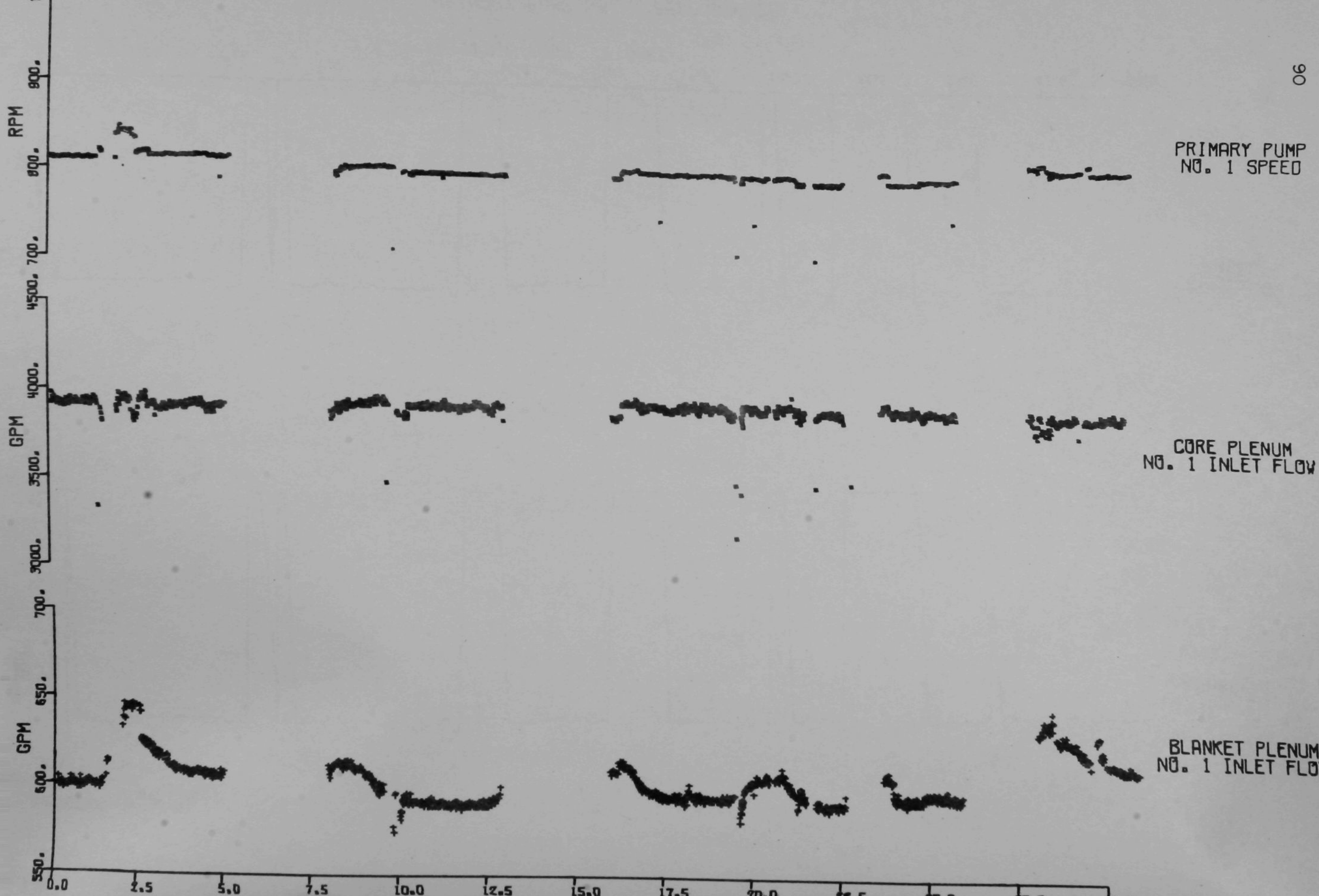


APRIL 1968 FIGURE 10

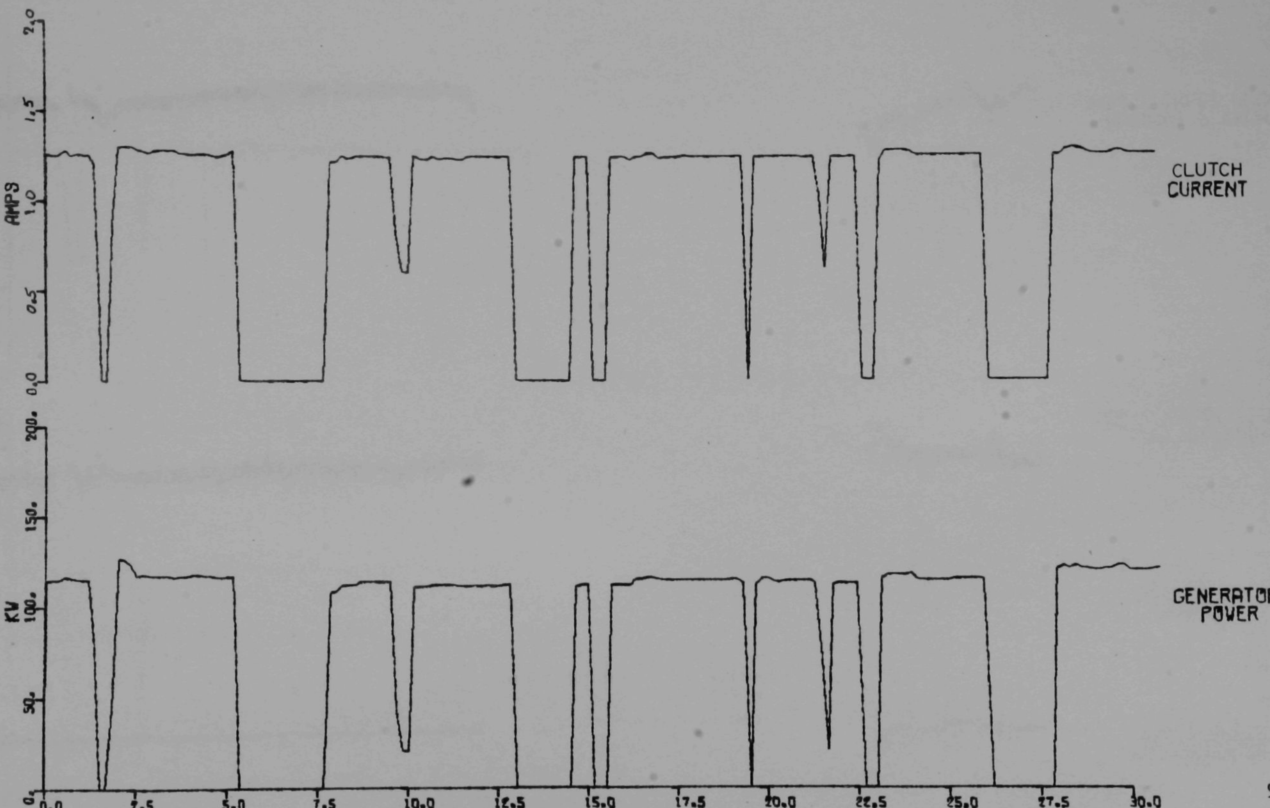


APRIL 1968 FIGURE 11

PRIMARY PUMP NO. 1 PERFORMANCE



MAY 1968 FIGURE 12



MAY 1968 FIGURE 13

PRIMARY PUMP NO. 1 PERFORMANCE

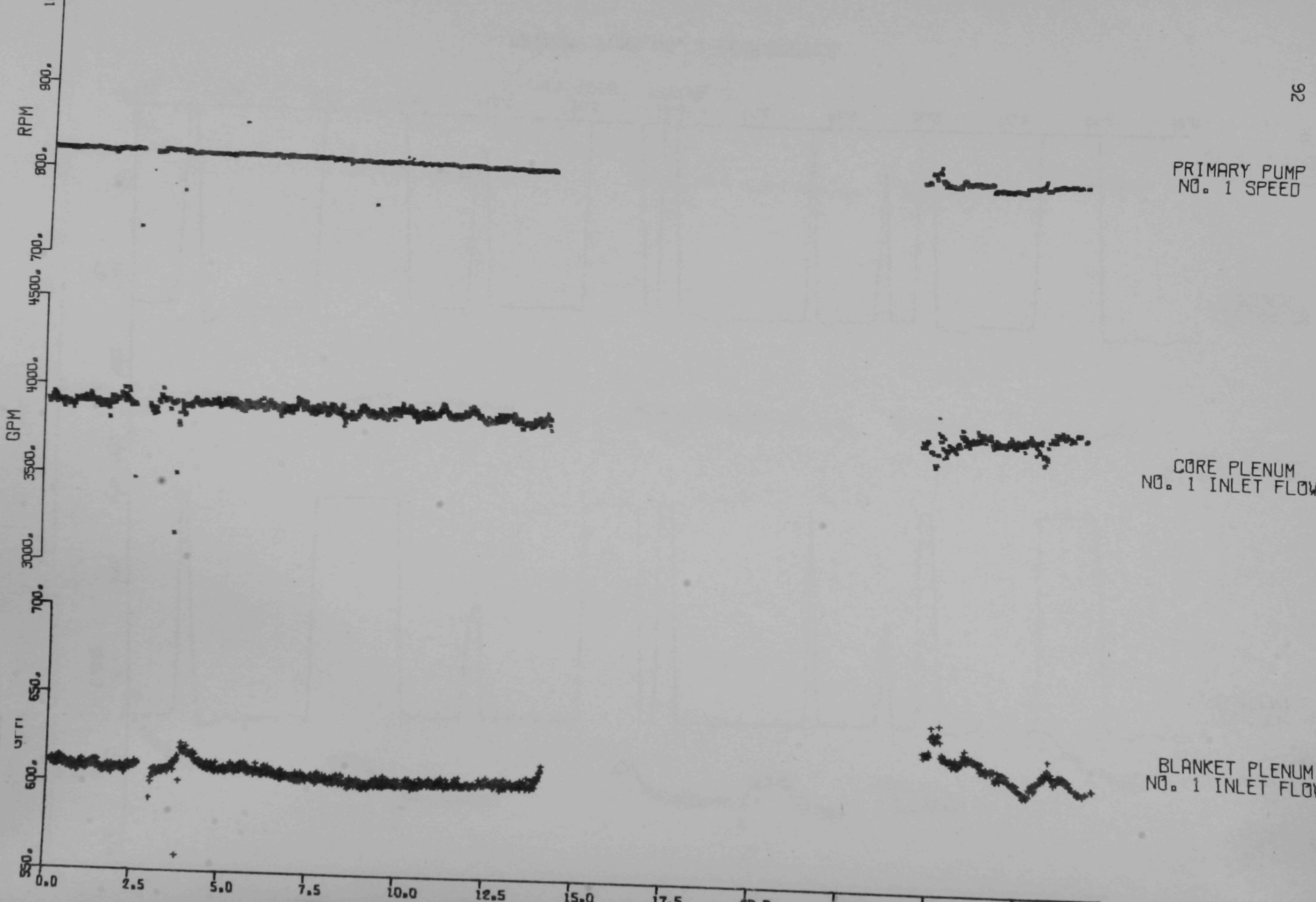
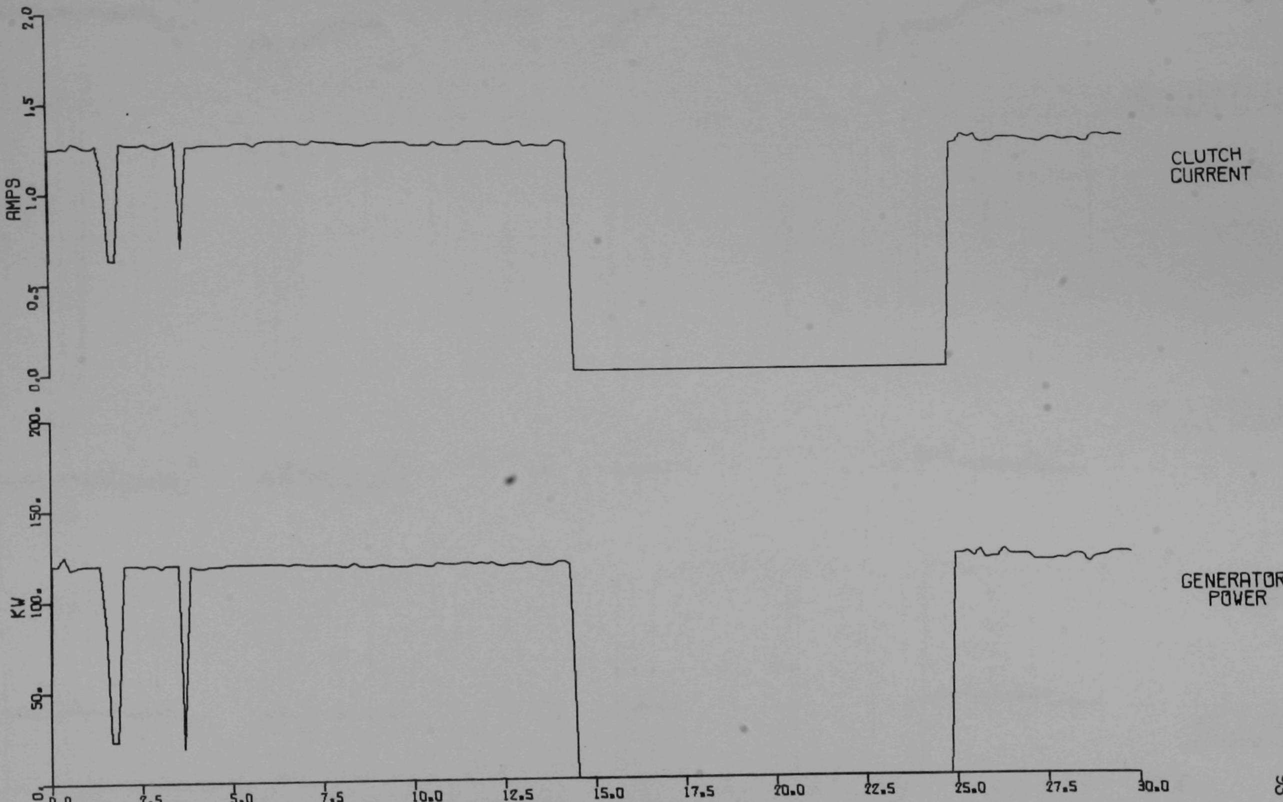
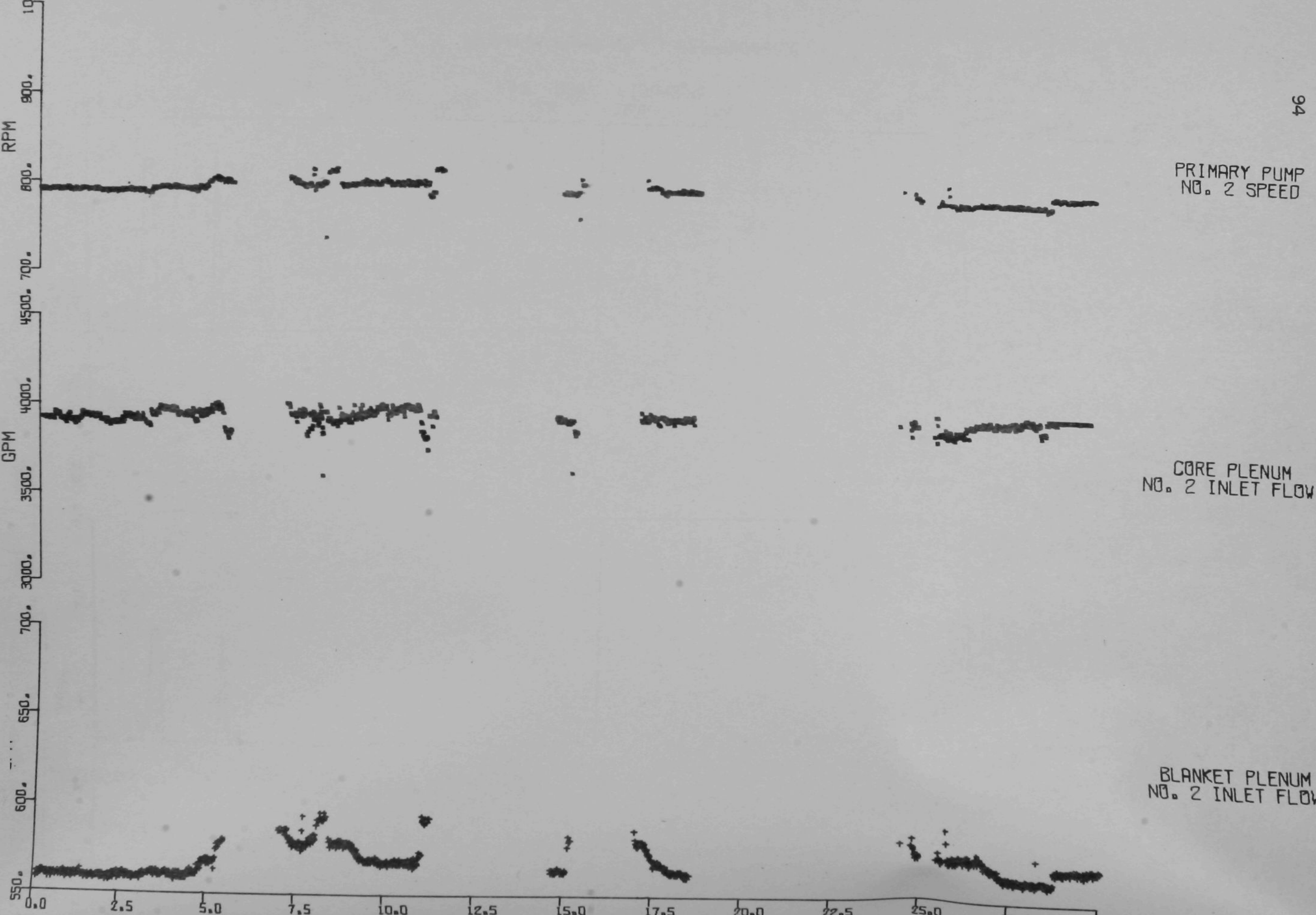

RPM
900.
800.
700.
PRIMARY PUMP
NO. 1 SPEED
GPM
4500.
4000.
3500.
3000.
CORE PLENUM
NO. 1 INLET FLOW
GPM
700.
650.
600.
550.
BLANKET PLENUM
NO. 1 INLET FLOW
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
27.5
30.0
JUNE 1968

FIGURE 14

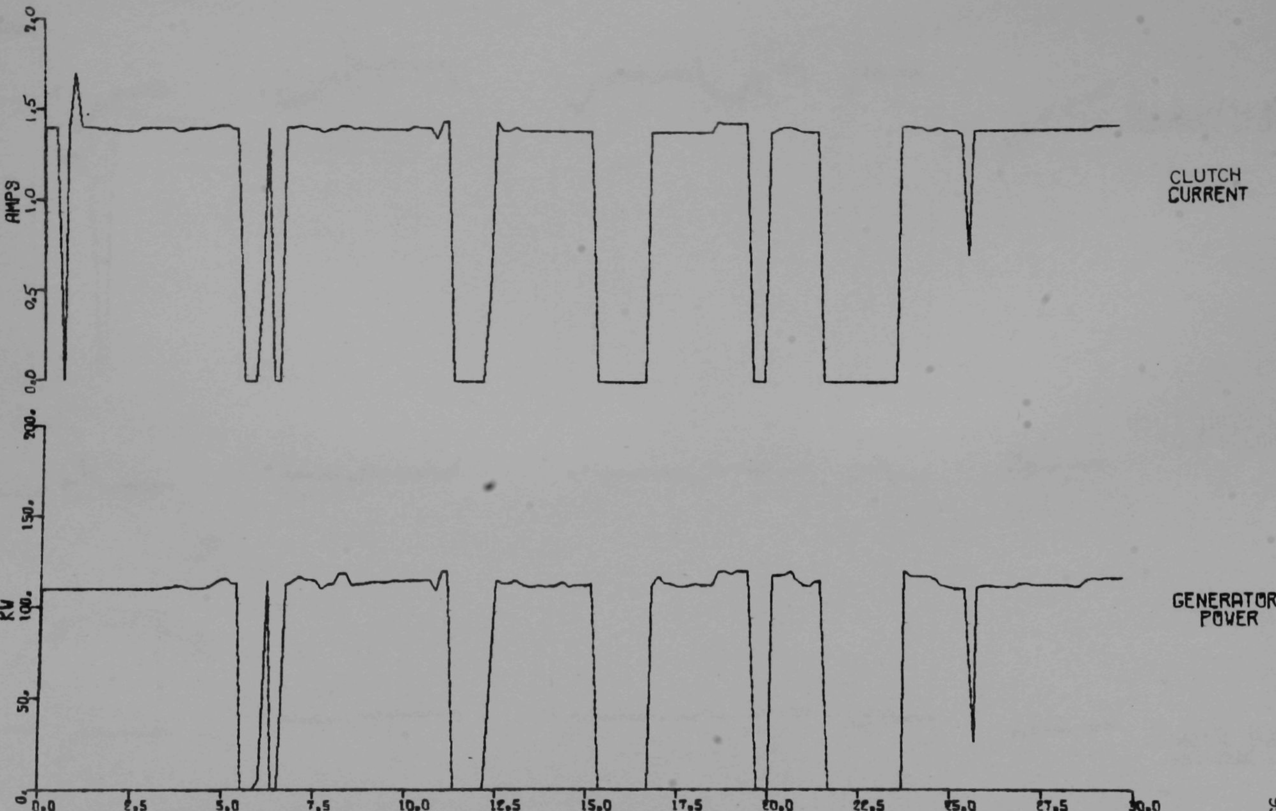


JUNE 1968 FIGURE 15

PRIMARY PUMP NO. 1 PERFORMANCE

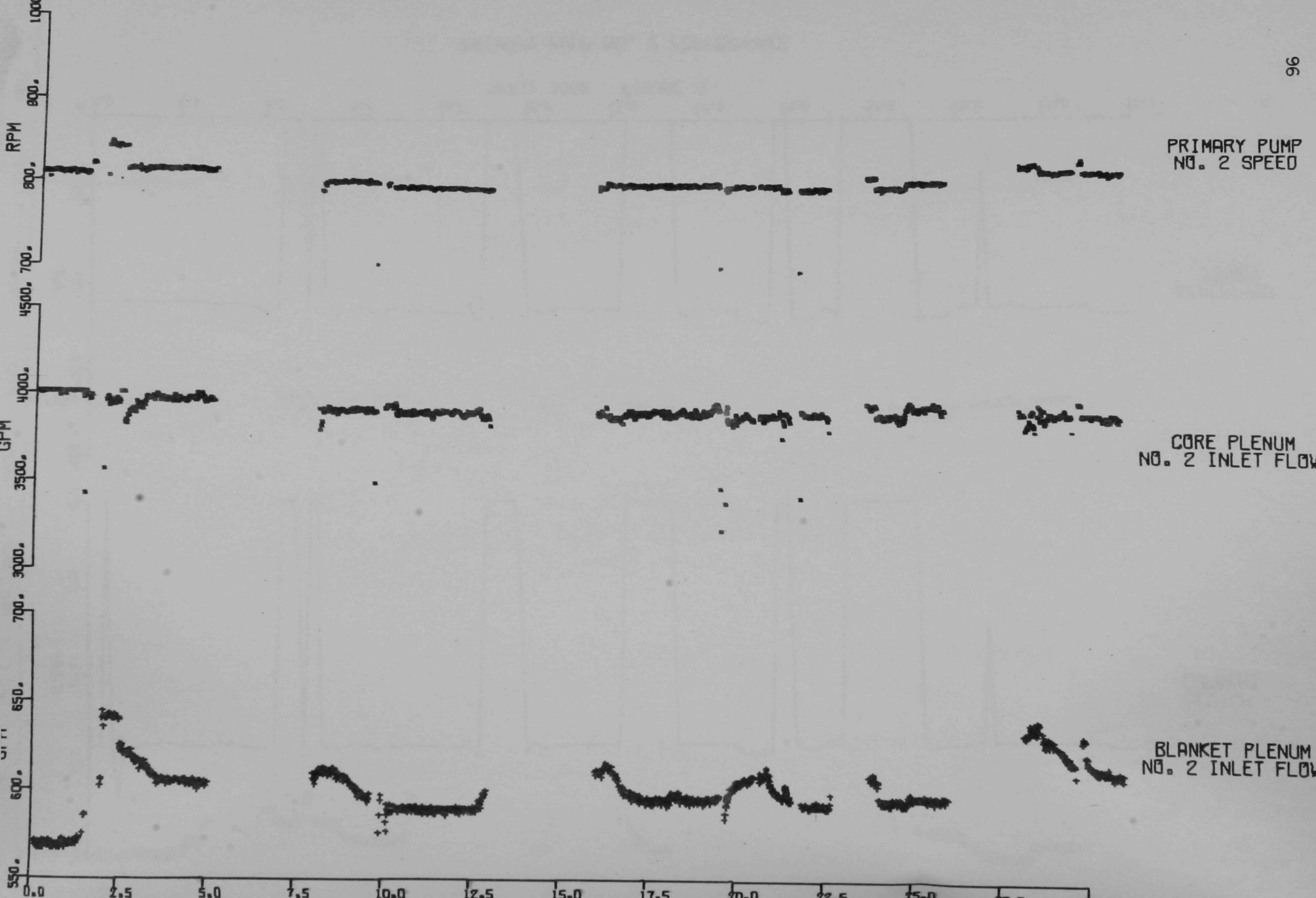


APRIL 1968 FIGURE 16

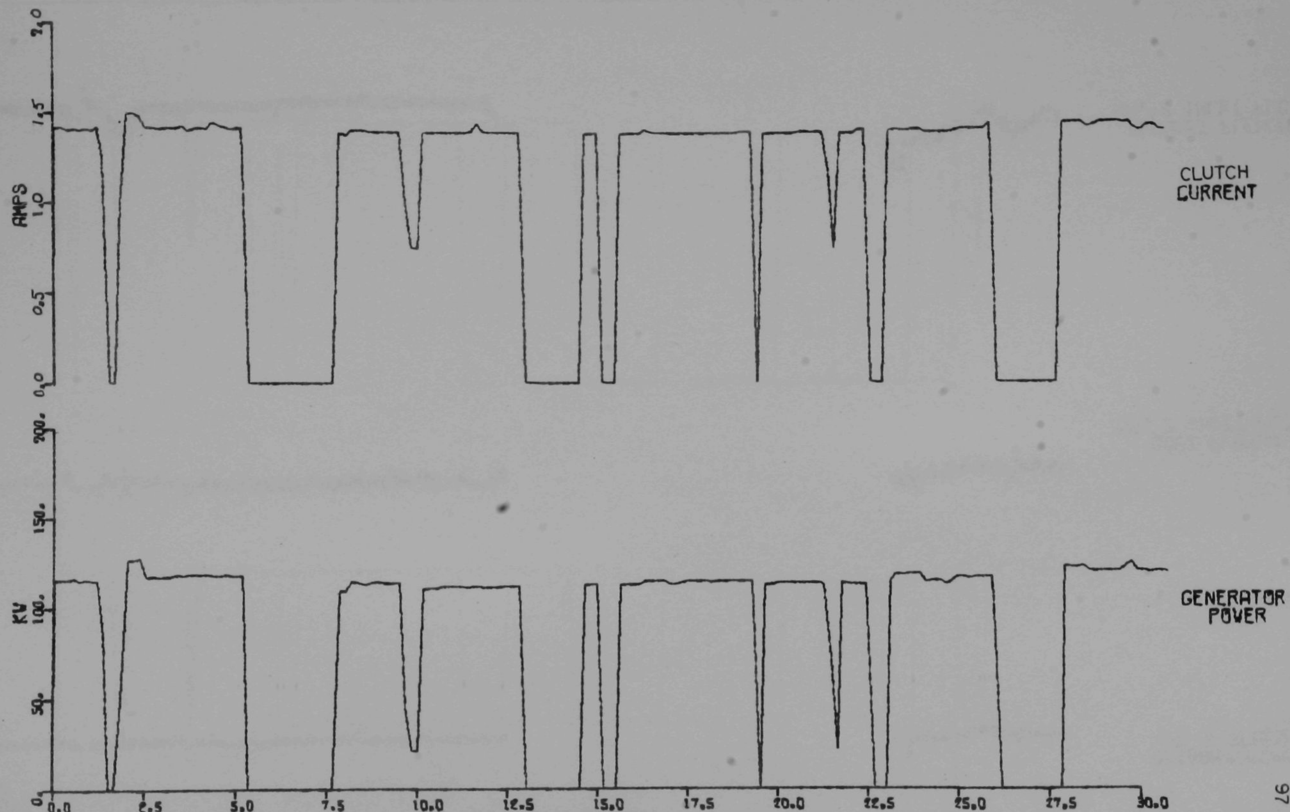


APRIL 1968 FIGURE 17

PRIMARY PUMP NO. 2 PERFORMANCE

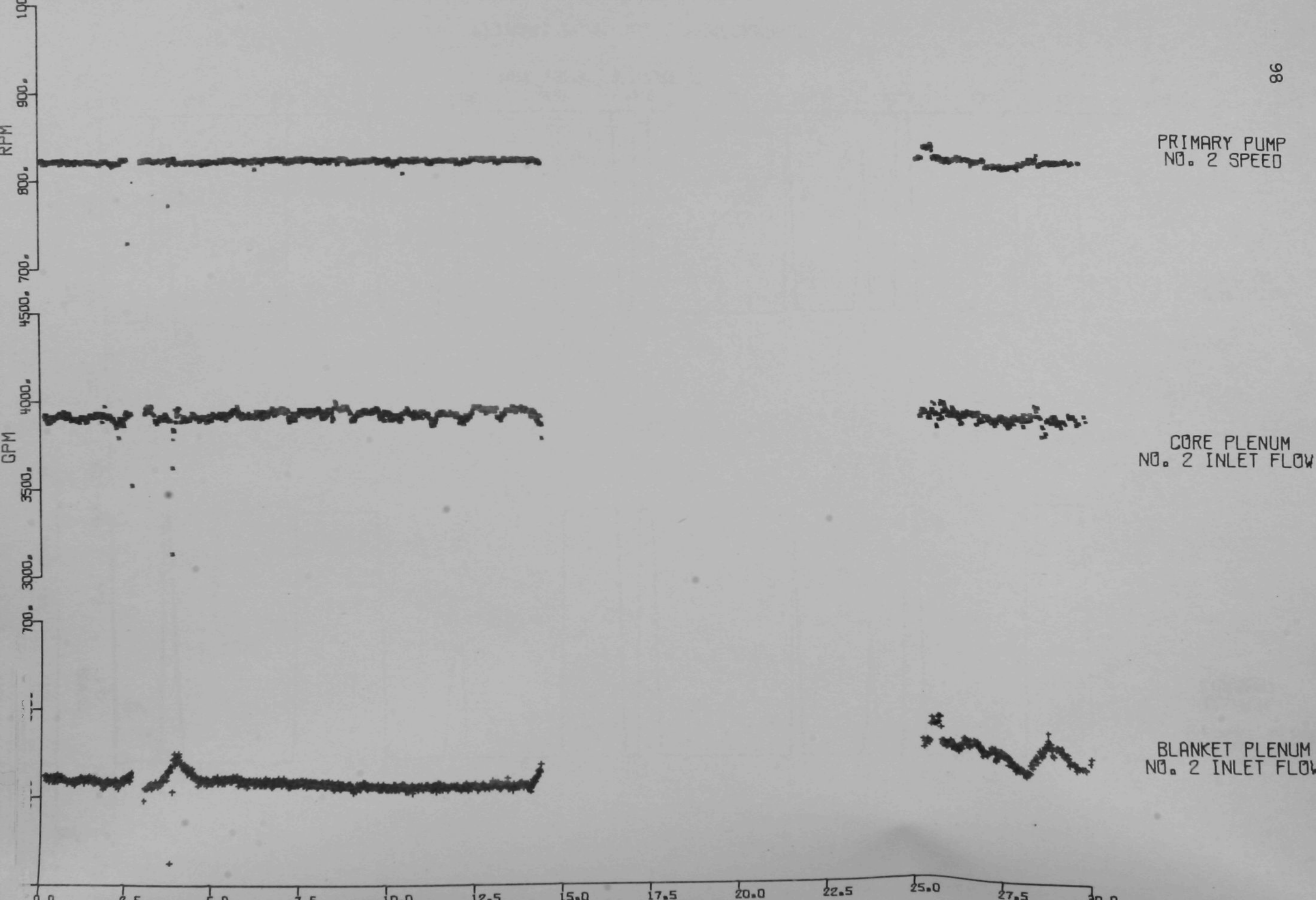


MAY 1968 FIGURE 18

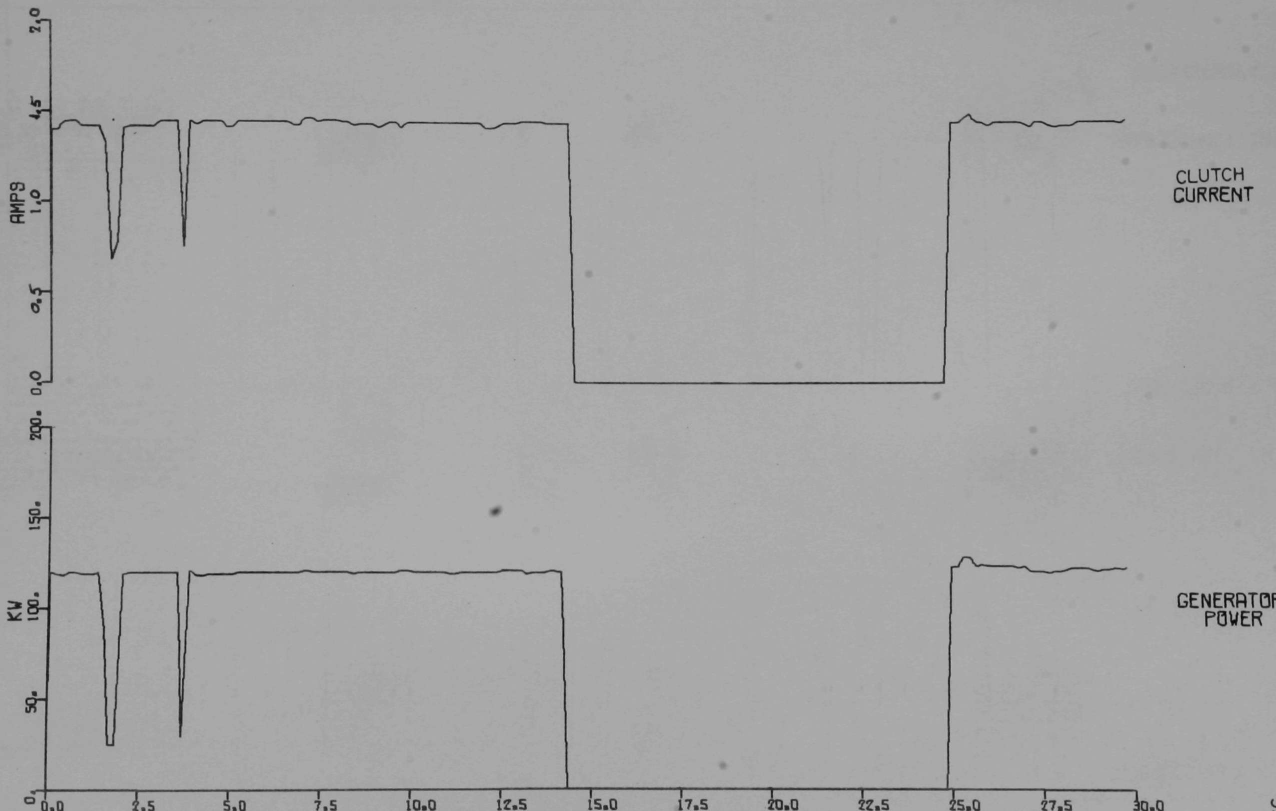


MAY 1968 FIGURE 19

PRIMARY PUMP NO. 2 PERFORMANCE

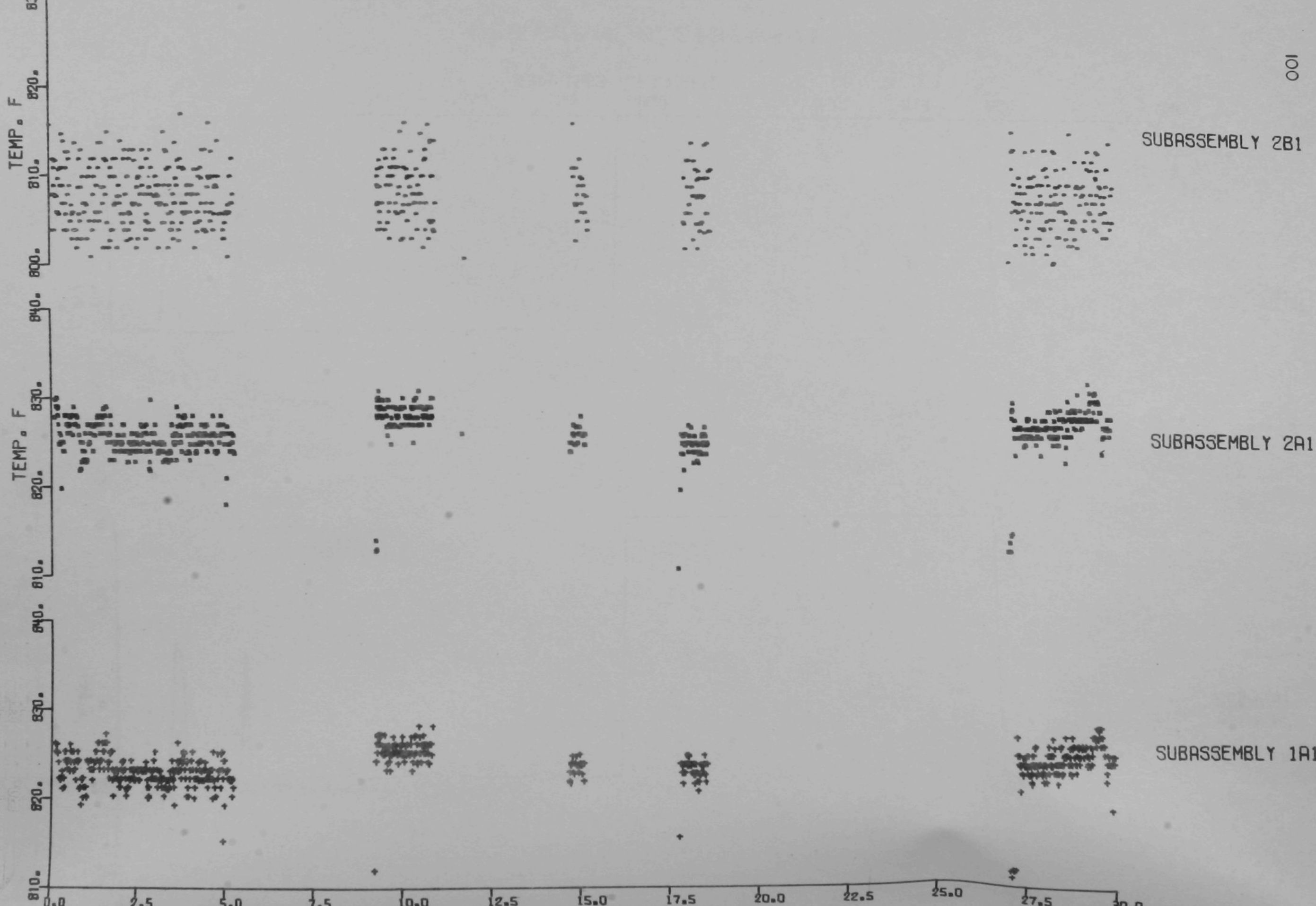


JUNE 1968 FIGURE 20

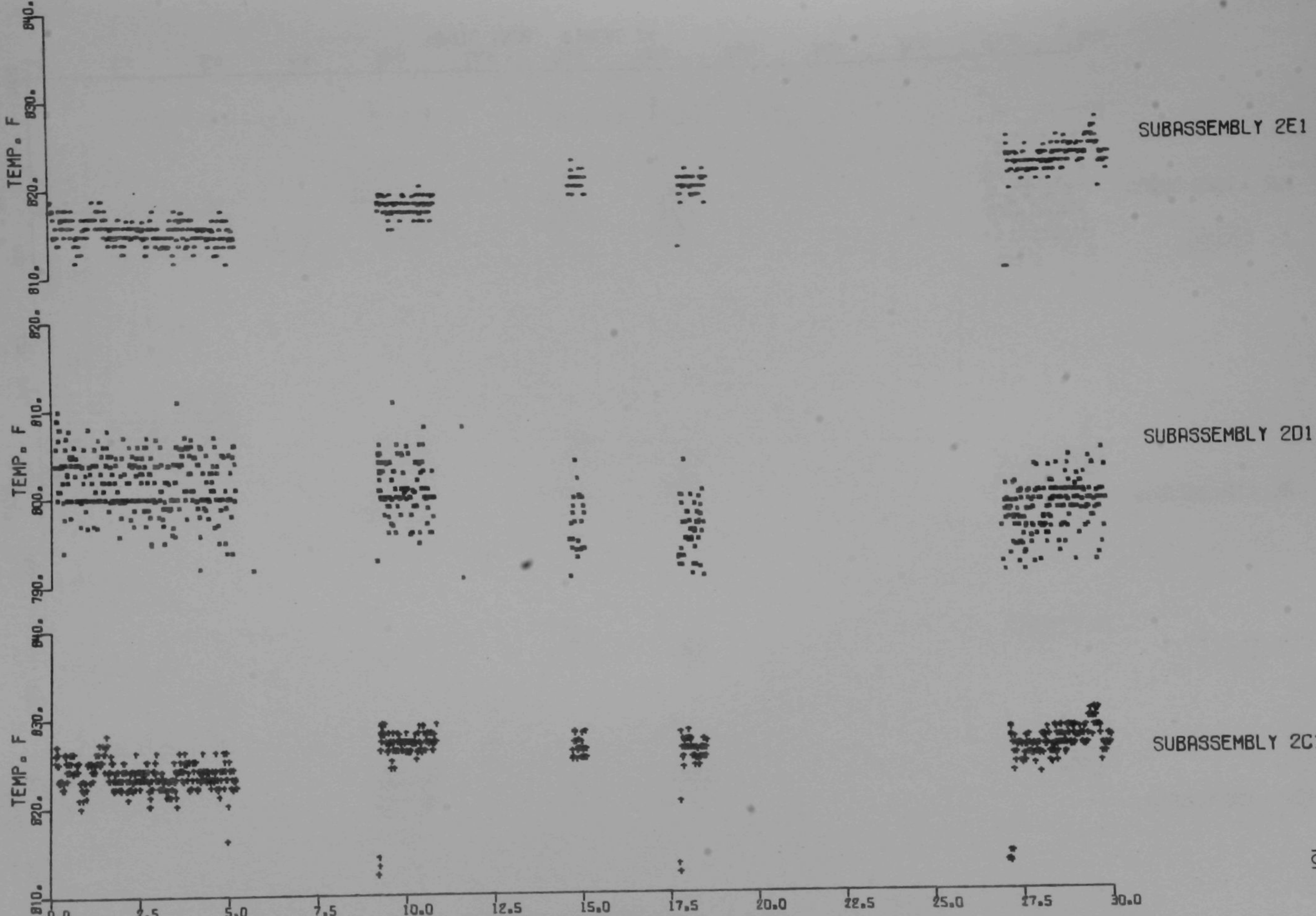


JUNE 1968 FIGURE 21

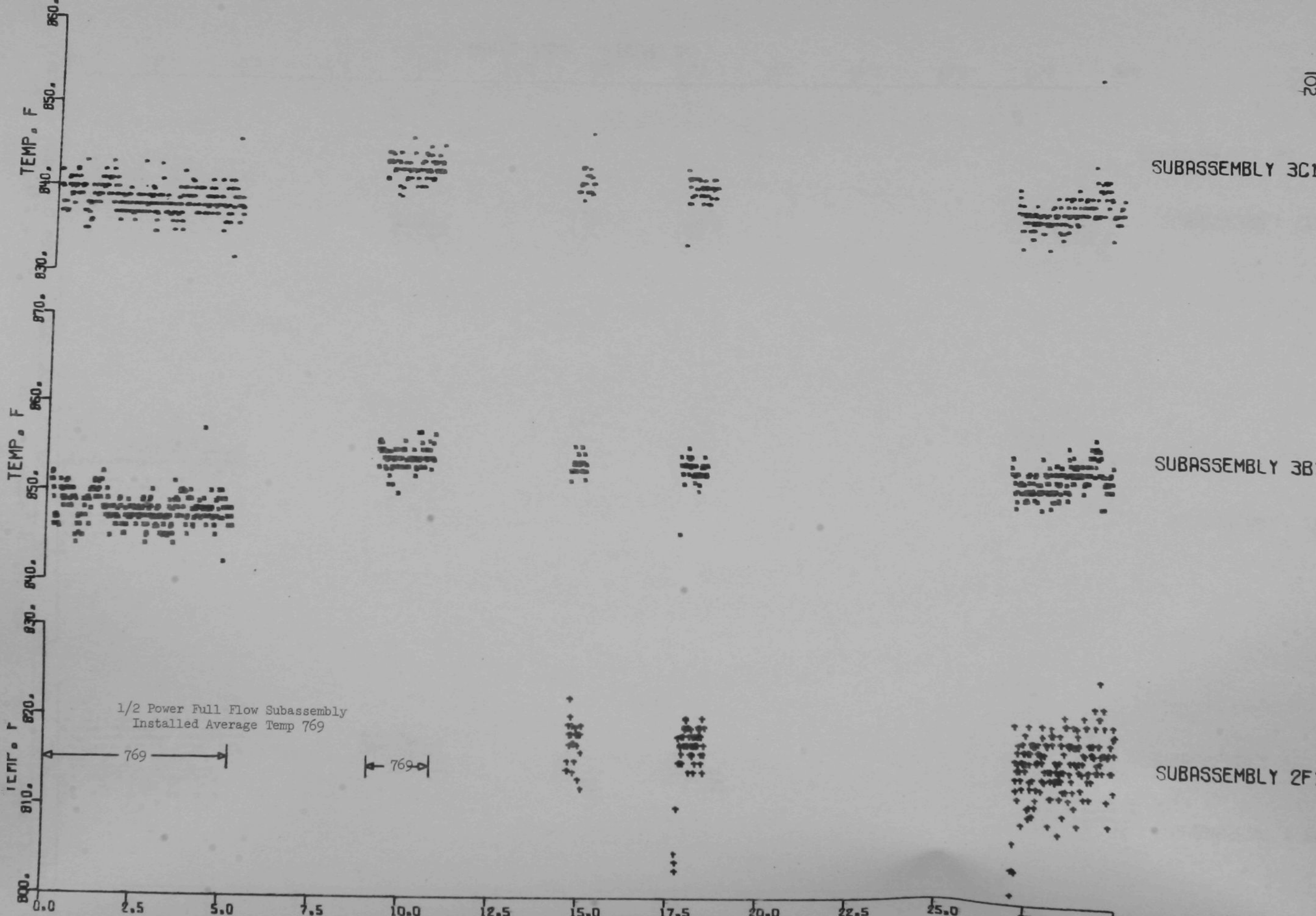
PRIMARY PUMP NO. 2 PERFORMANCE



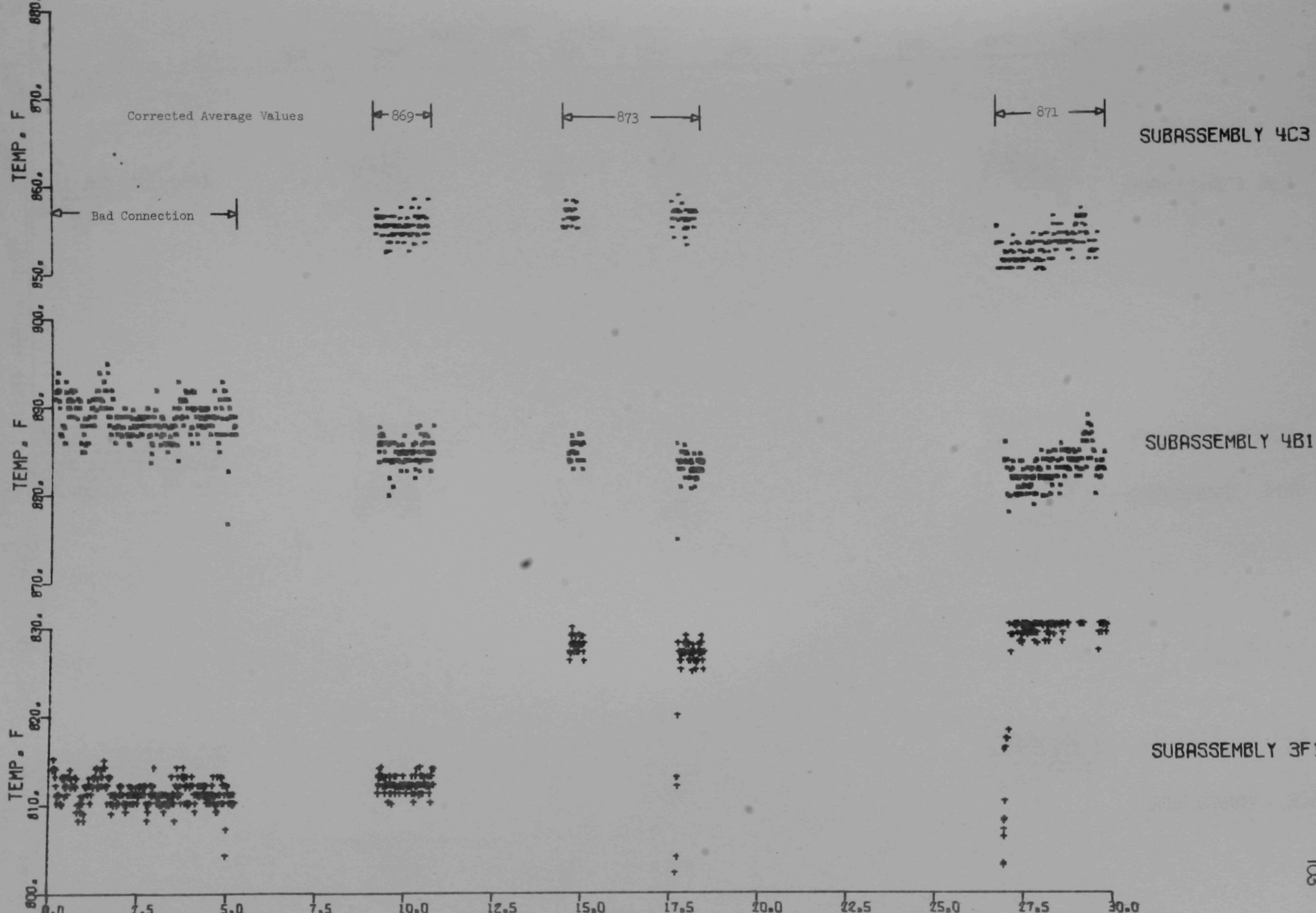
APRIL 1968 FIGURE 22



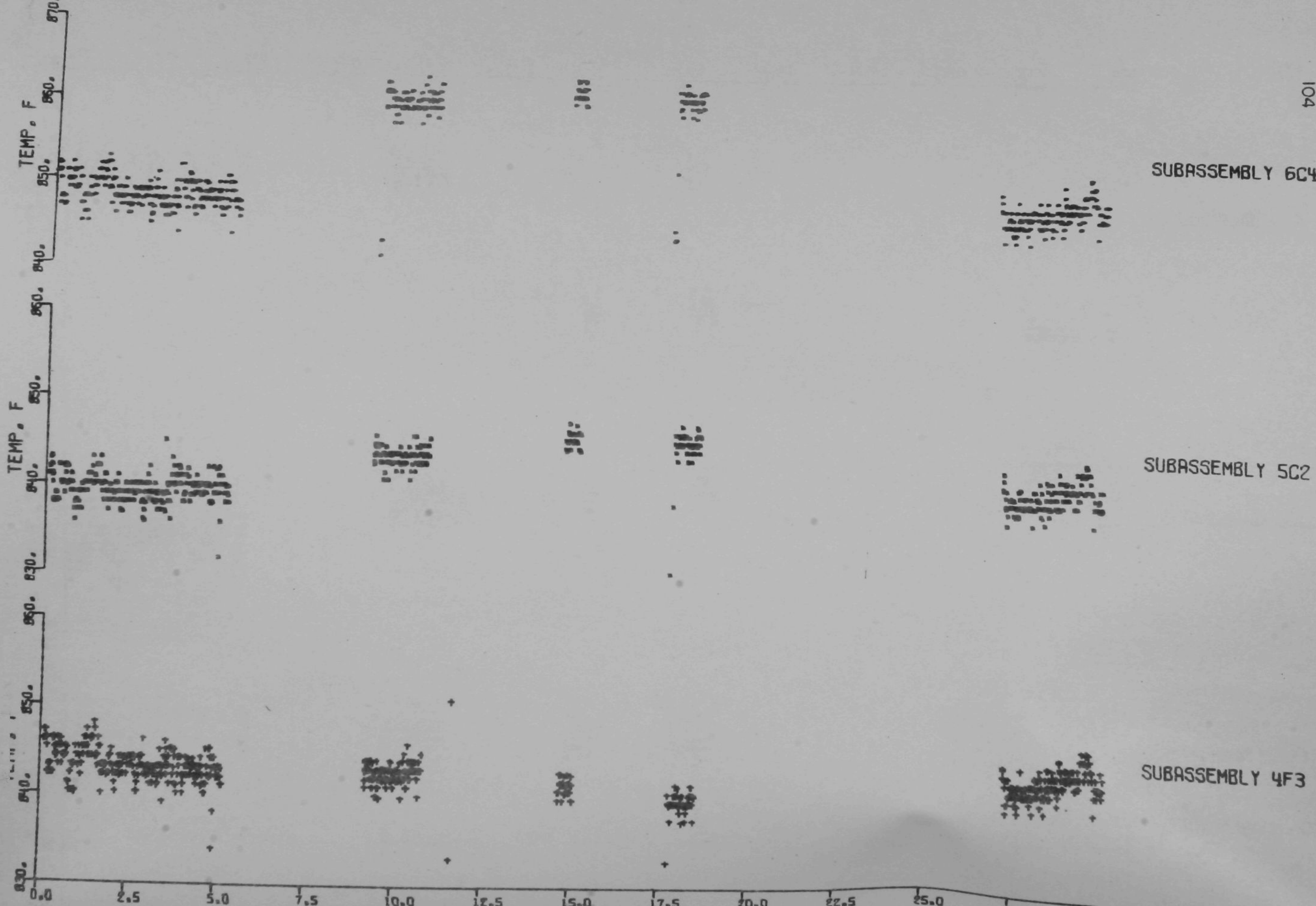
APRIL 1968 FIGURE 23



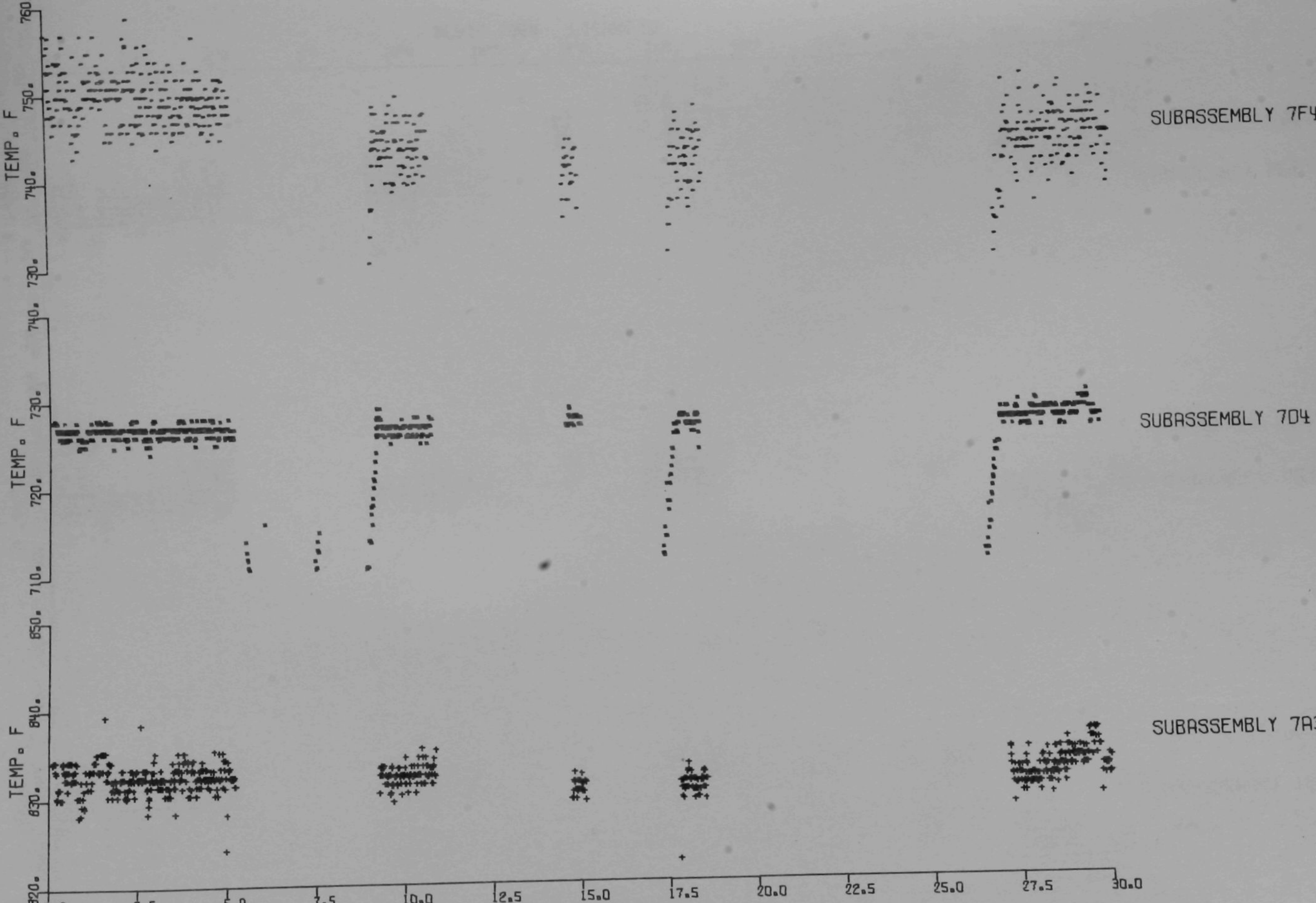
APRIL 1968 FIGURE 24



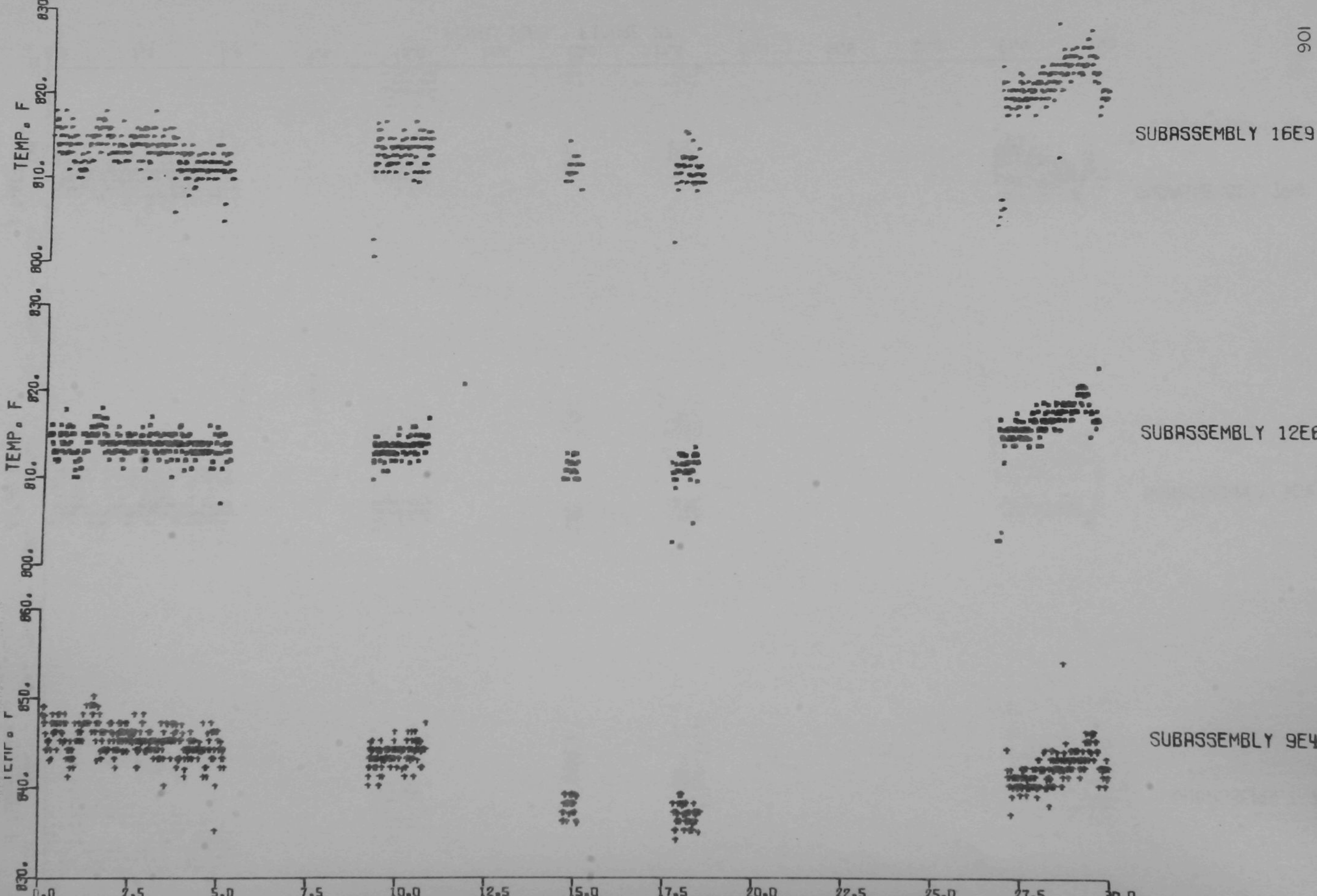
APRIL 1968 FIGURE 25



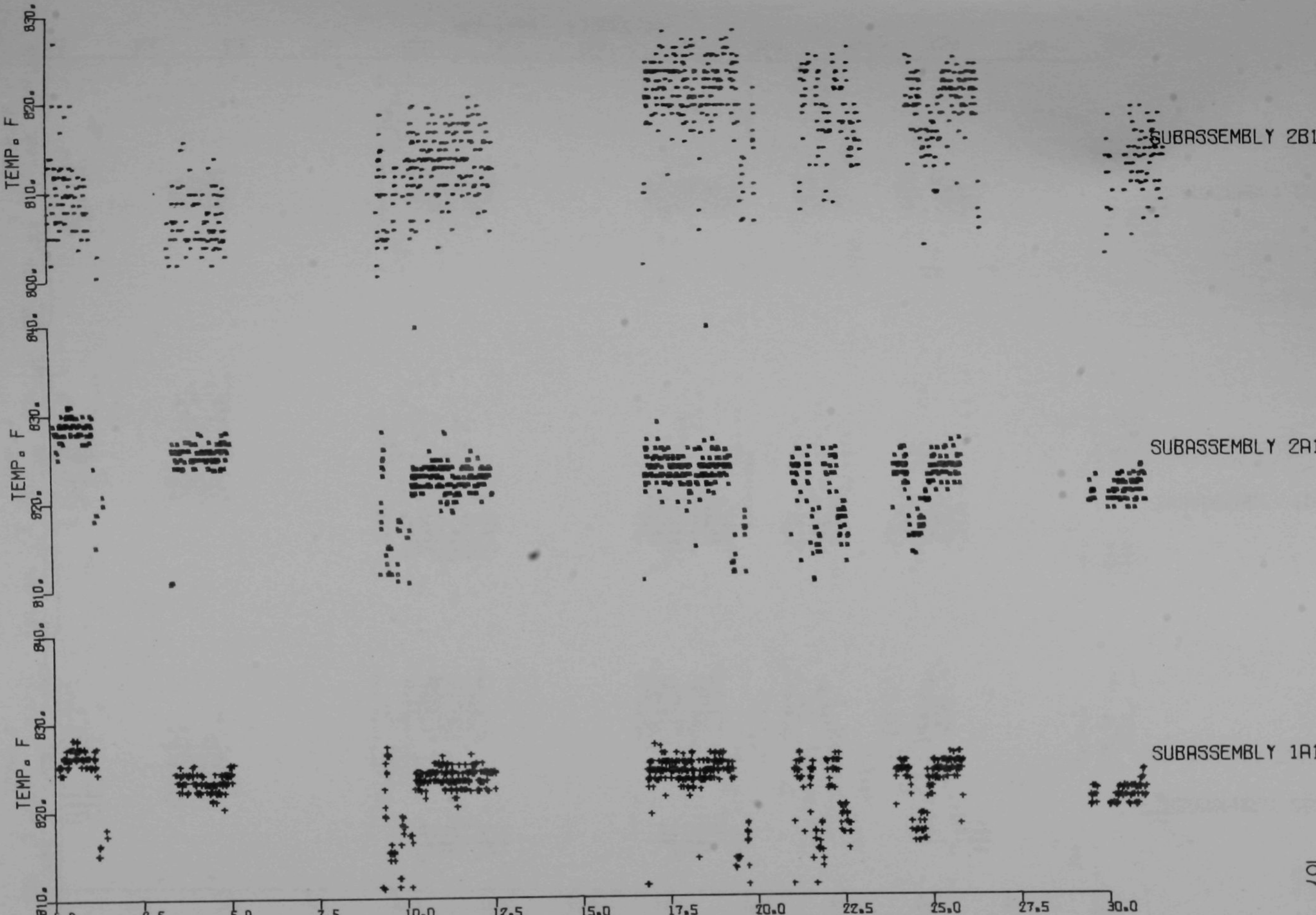
APRIL 1968 FIGURE 26



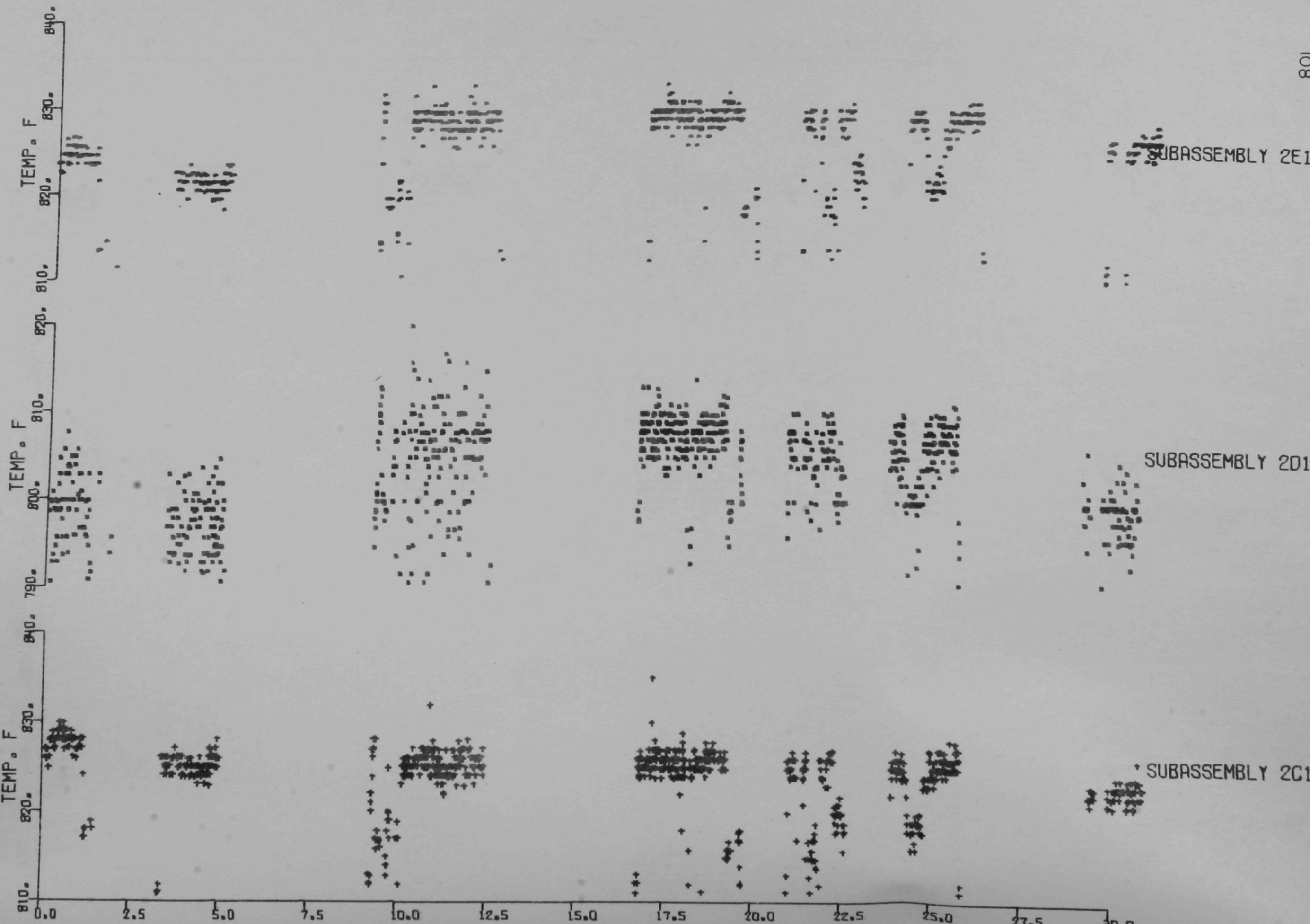
APRIL 1968 FIGURE 27



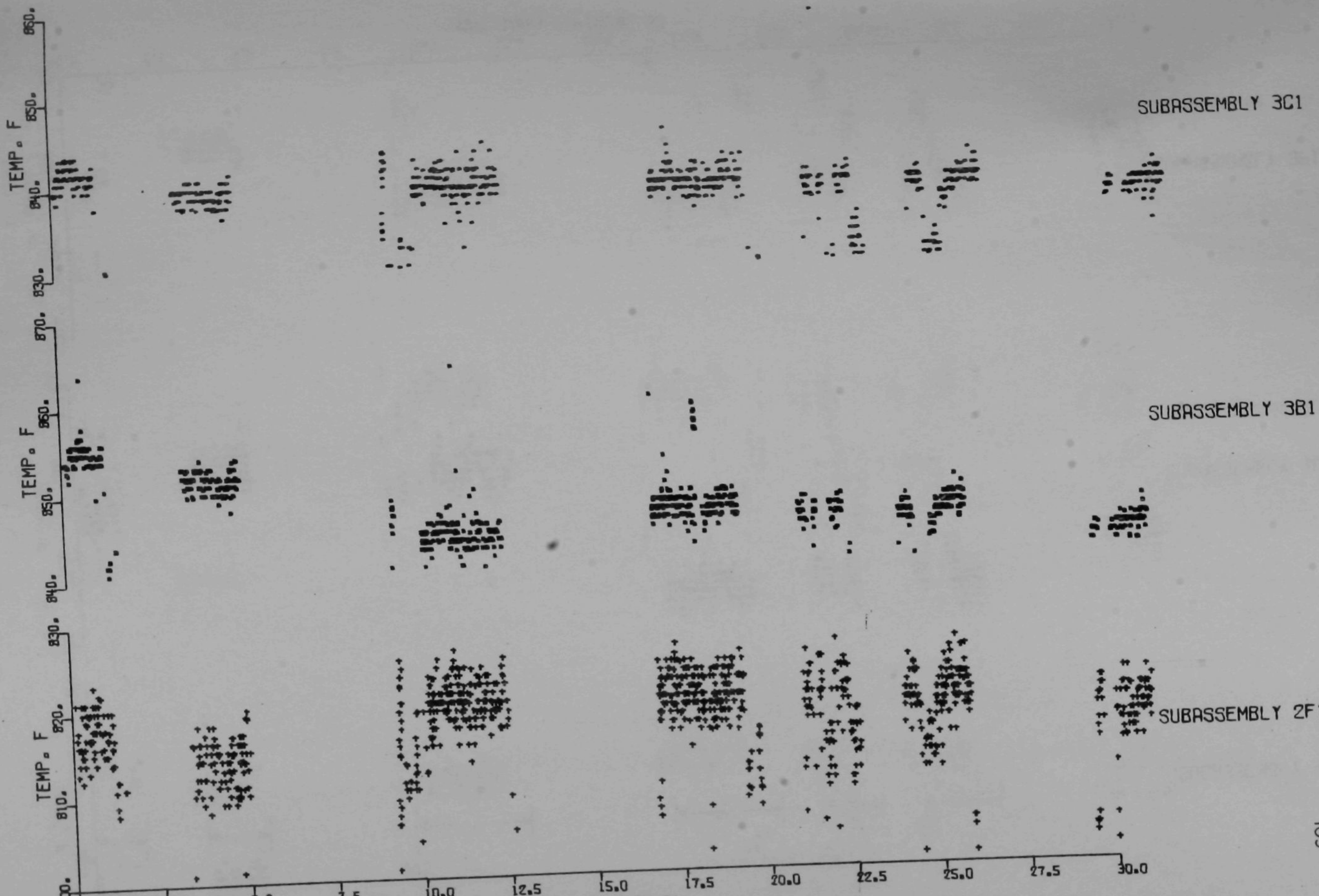
APRIL 1968 FIGURE 28



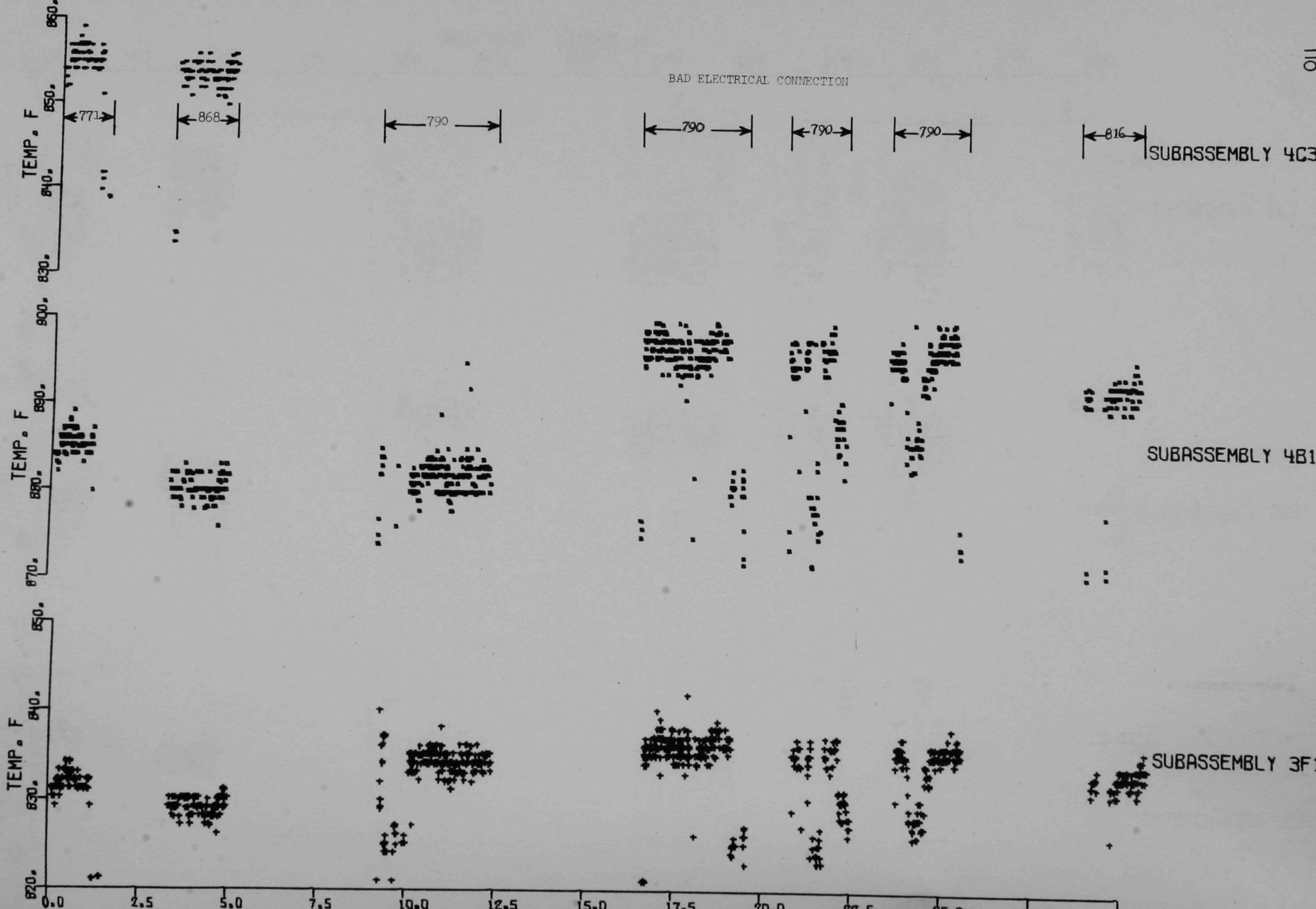
MAY 1968 FIGURE 29



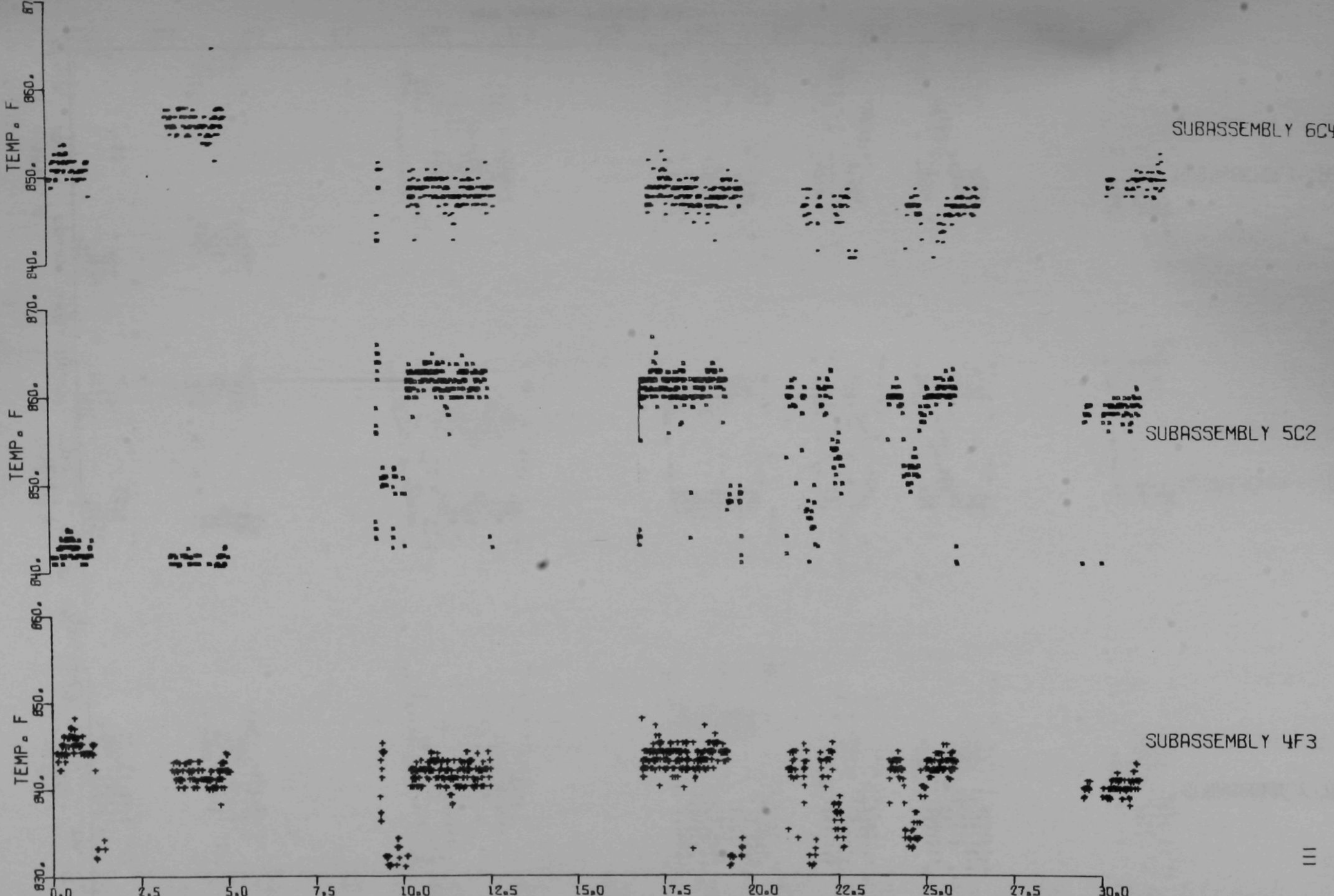
MAY 1968 FIGURE 30



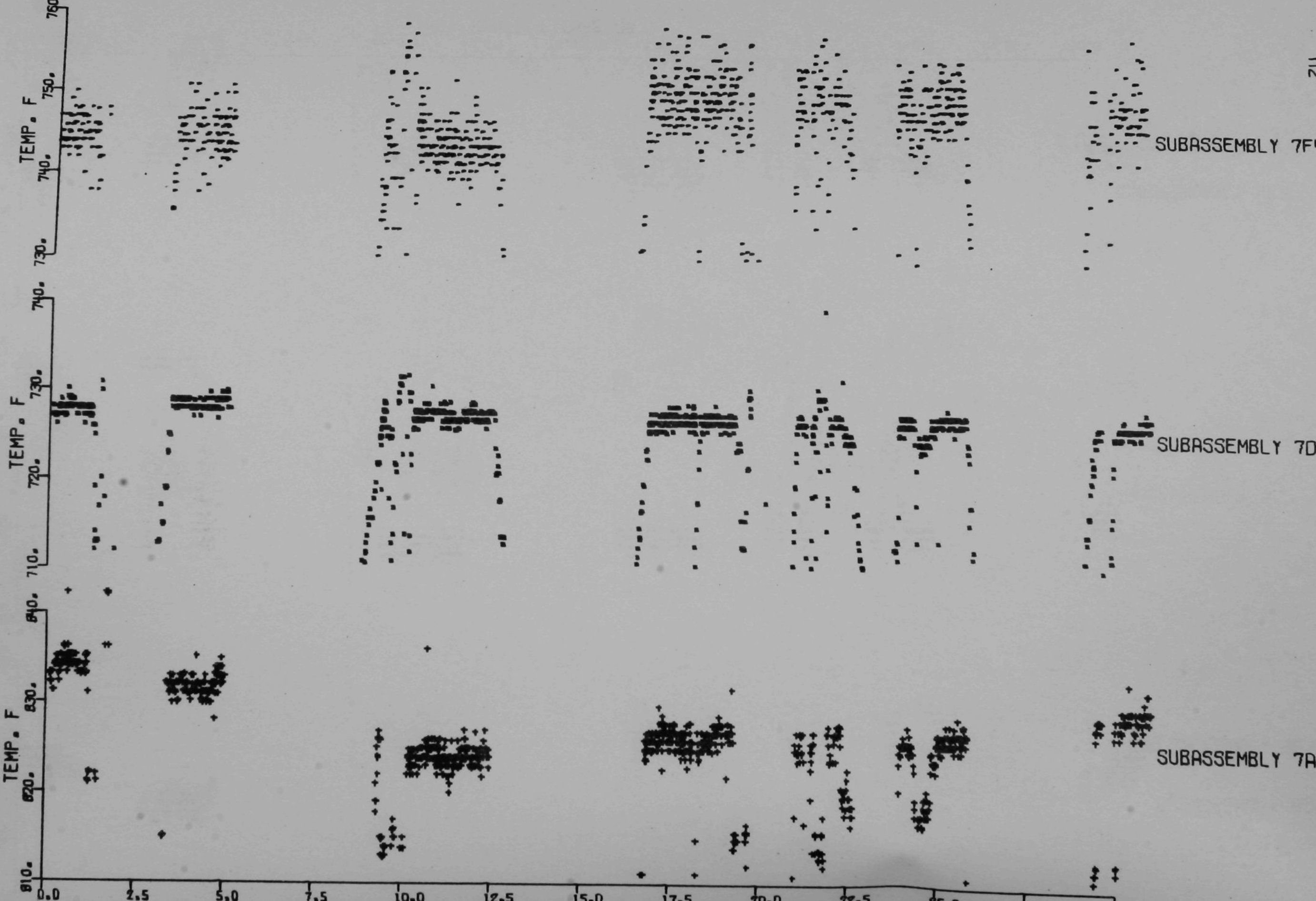
MAY 1968 FIGURE 31



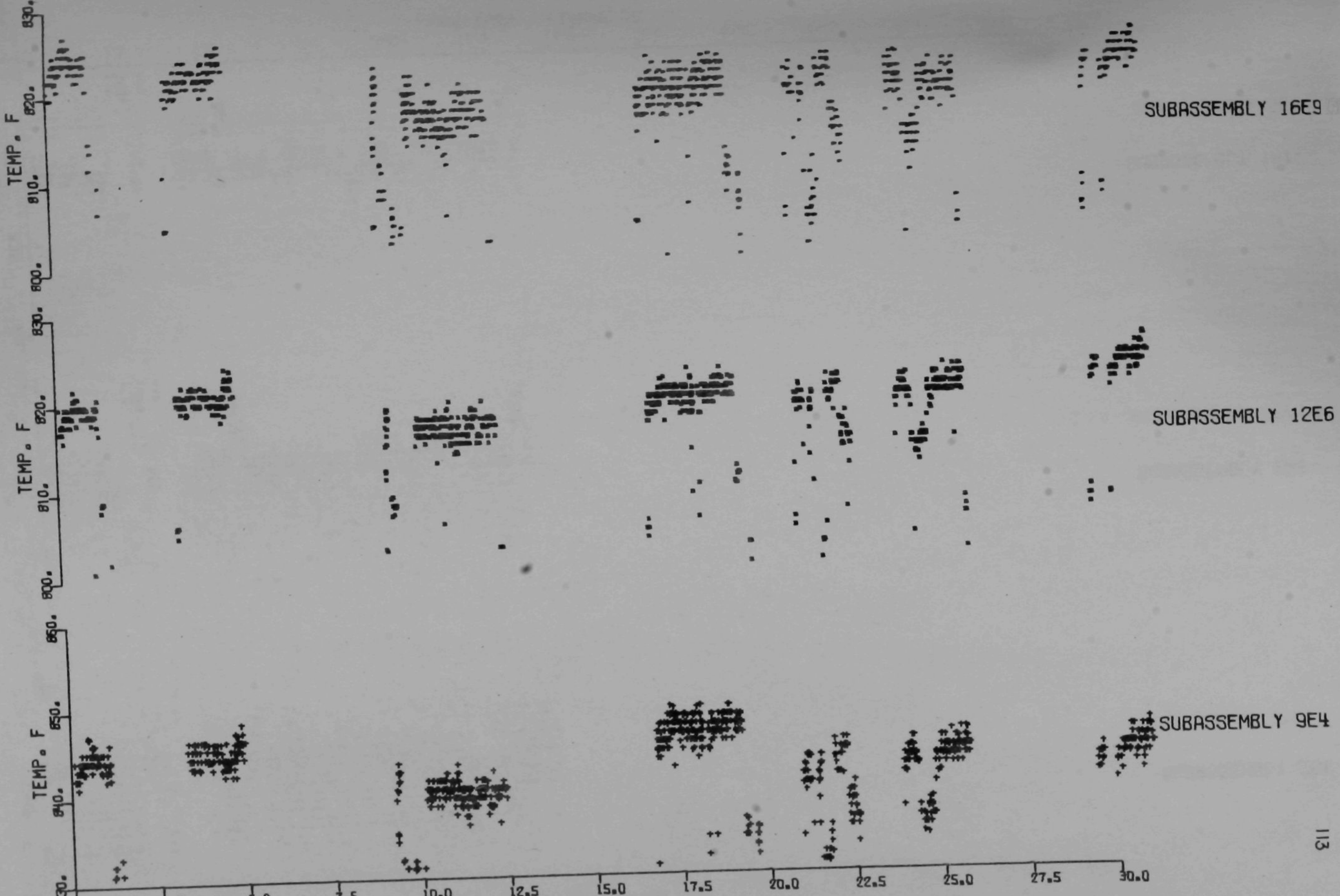
MAY 1968 FIGURE 32



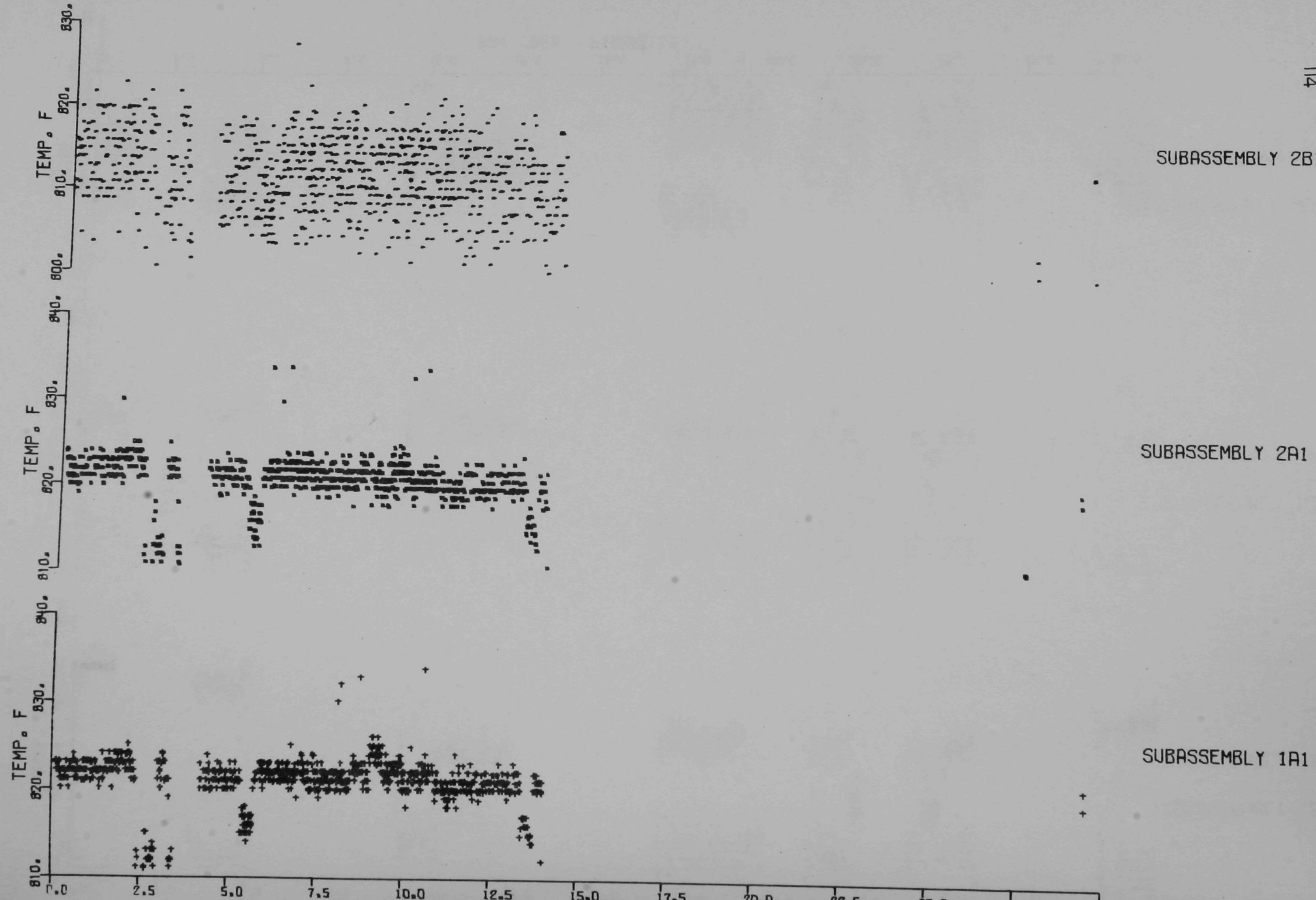
MAY 1968 FIGURE 33



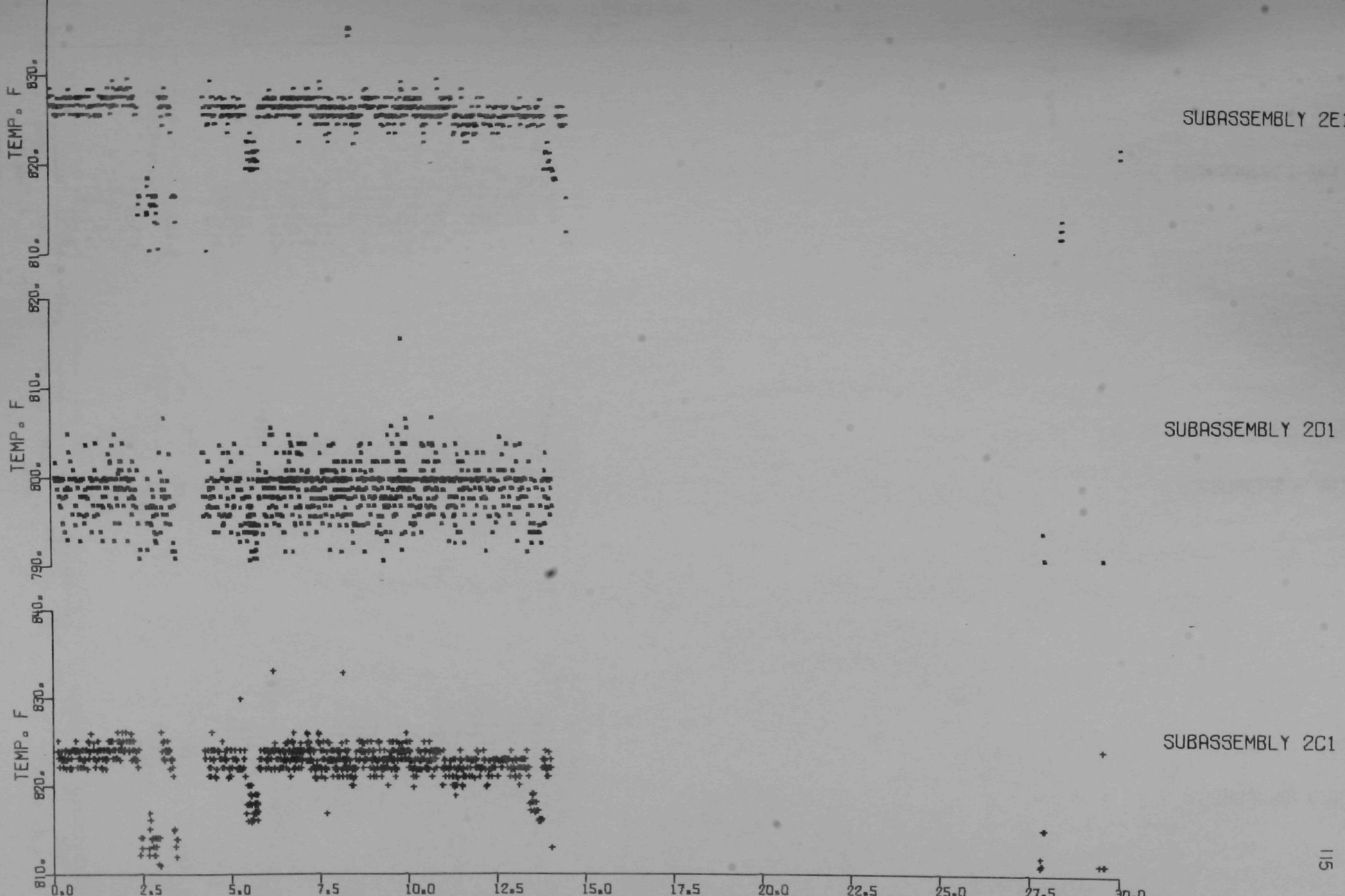
MAY 1968 FIGURE 34



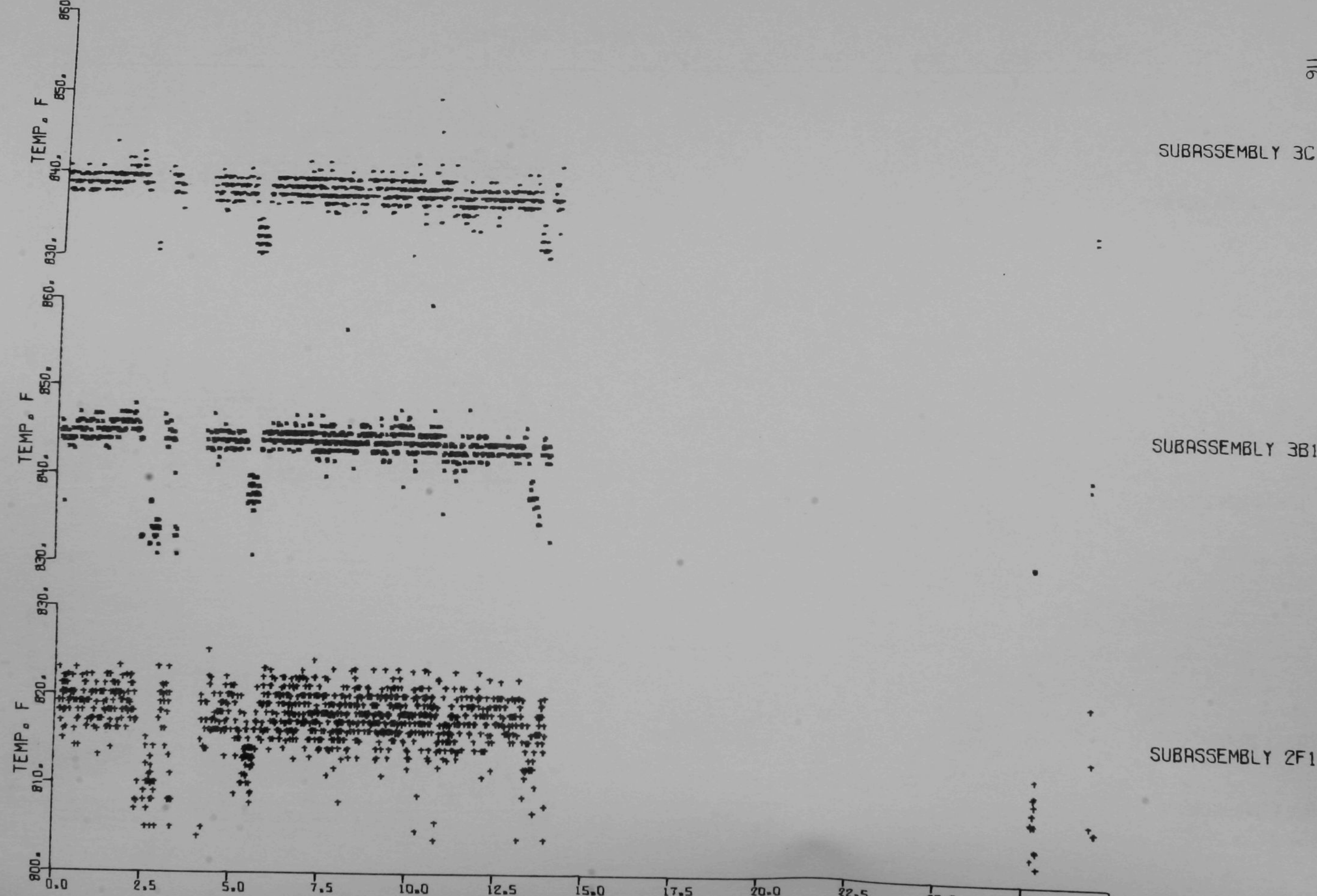
MAY 1968 FIGURE 35



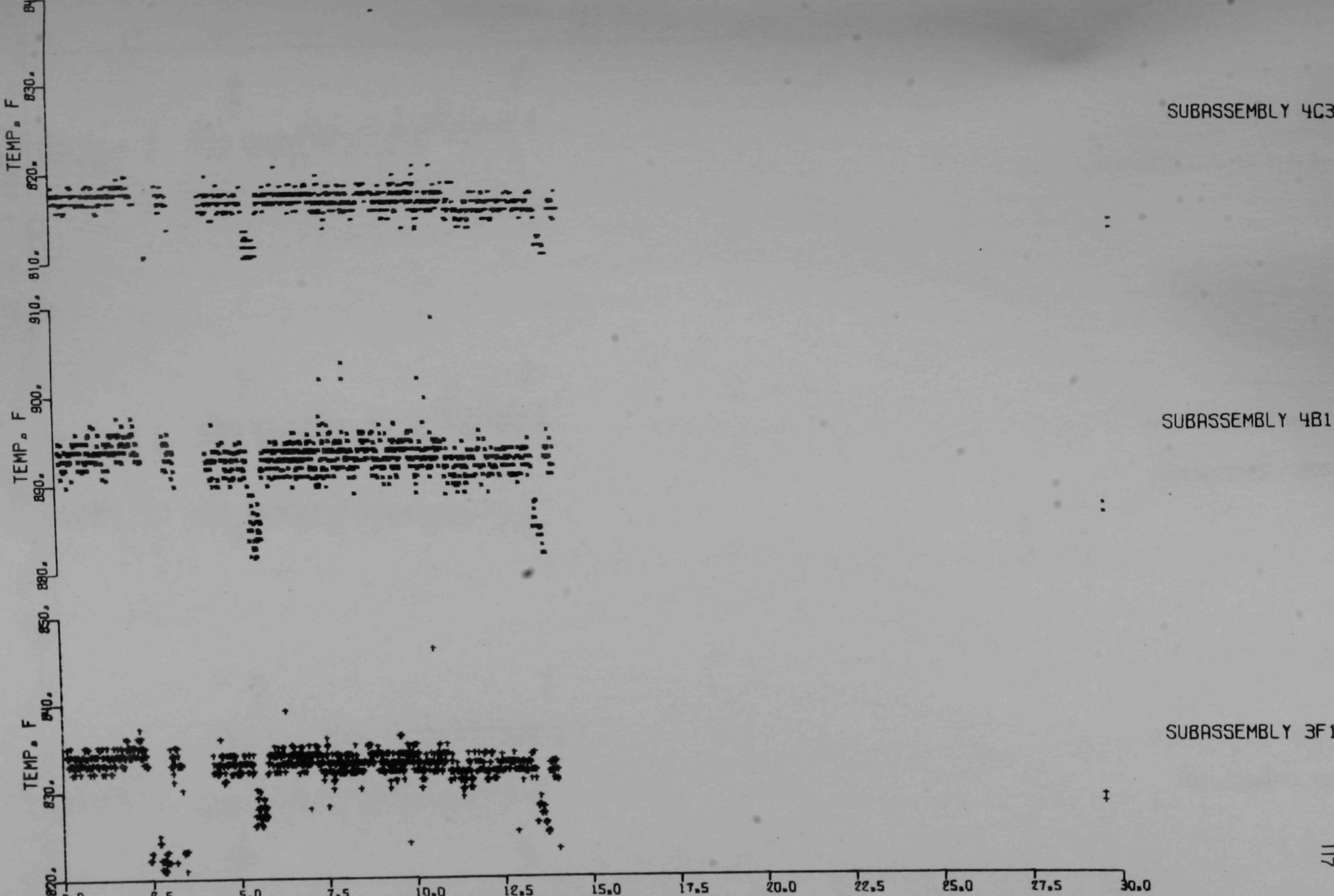
JUNE 1968 FIGURE 36



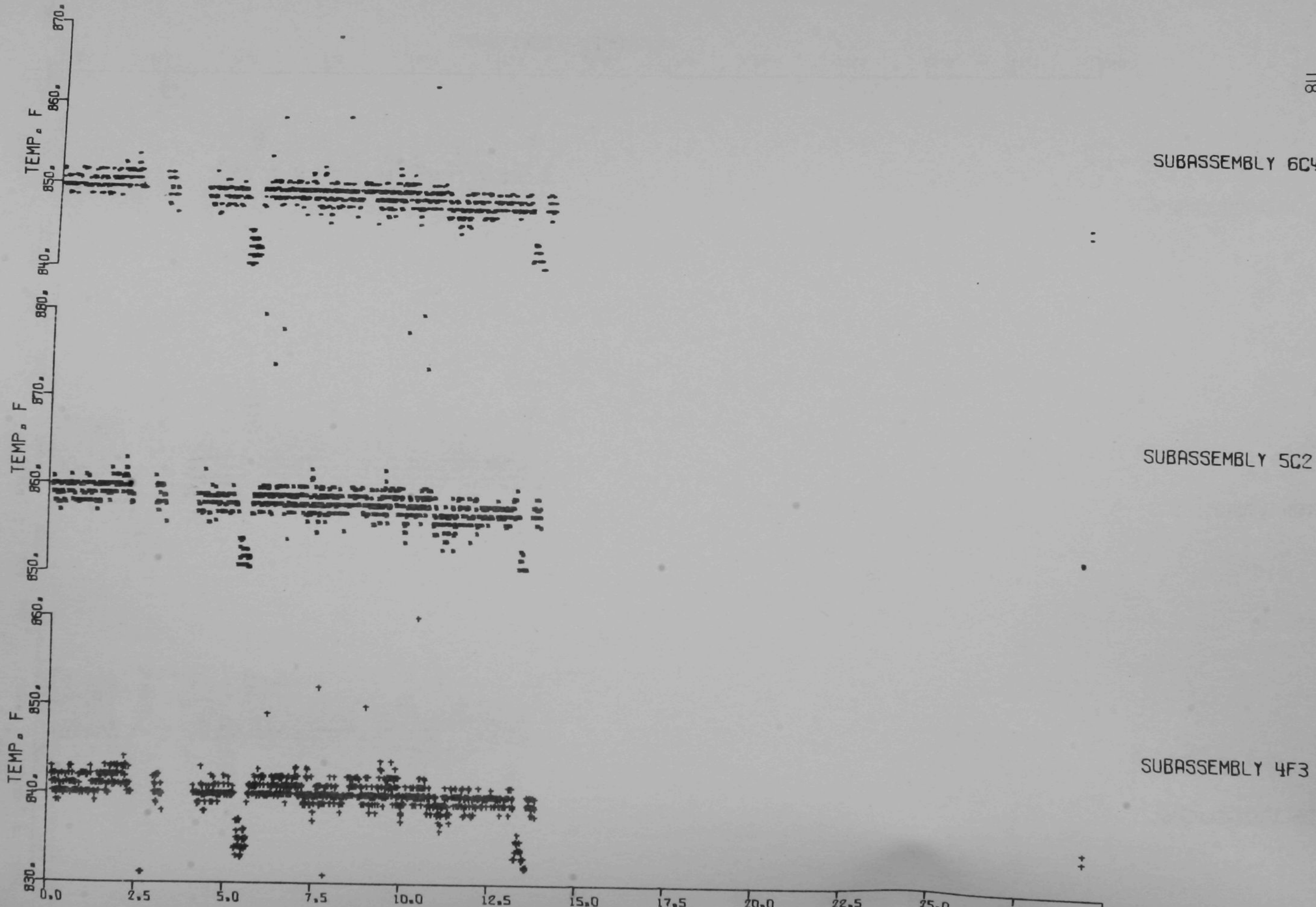
JUNE 1968 FIGURE 37



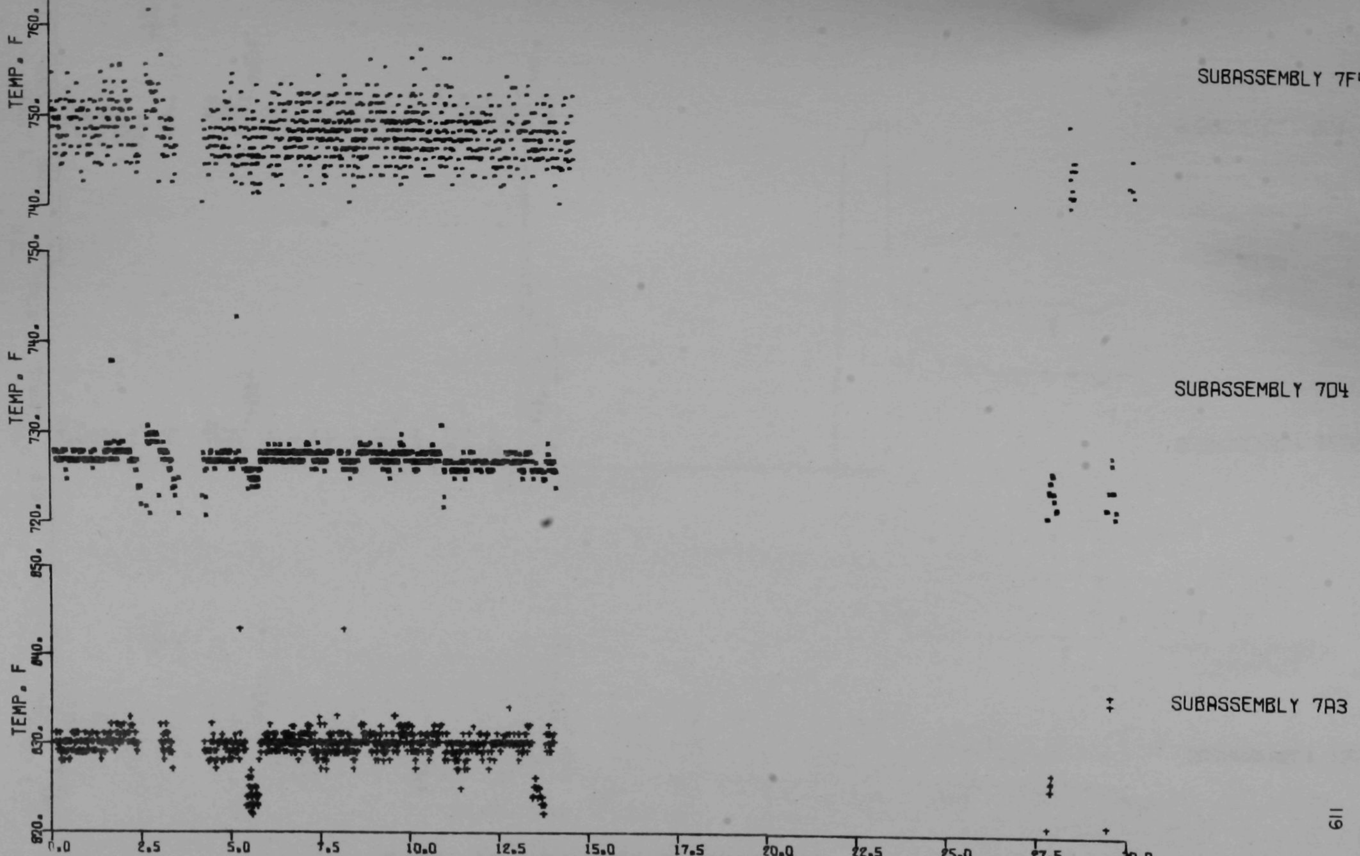
JUNE 1968 FIGURE 38



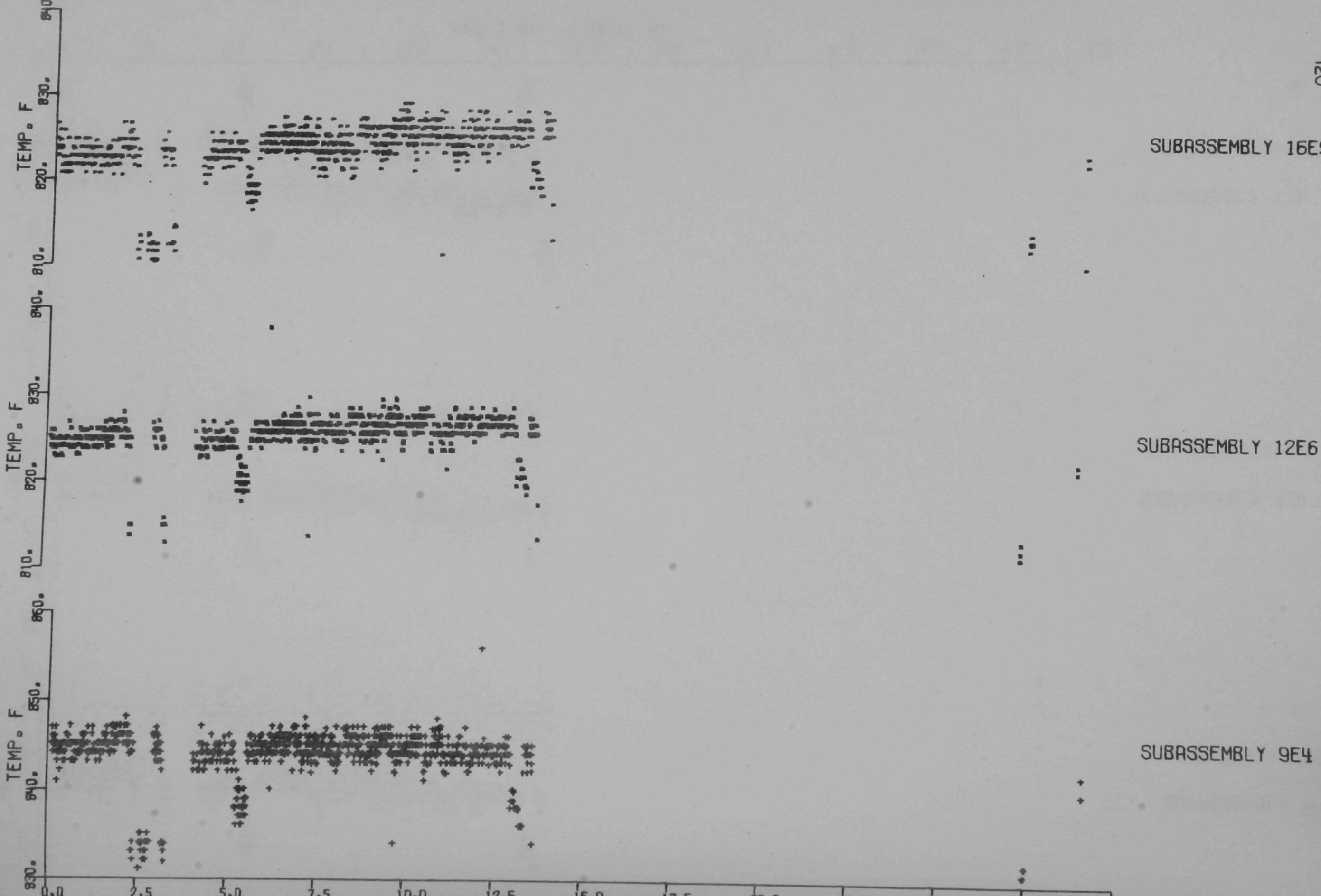
JUNE 1968 FIGURE 39



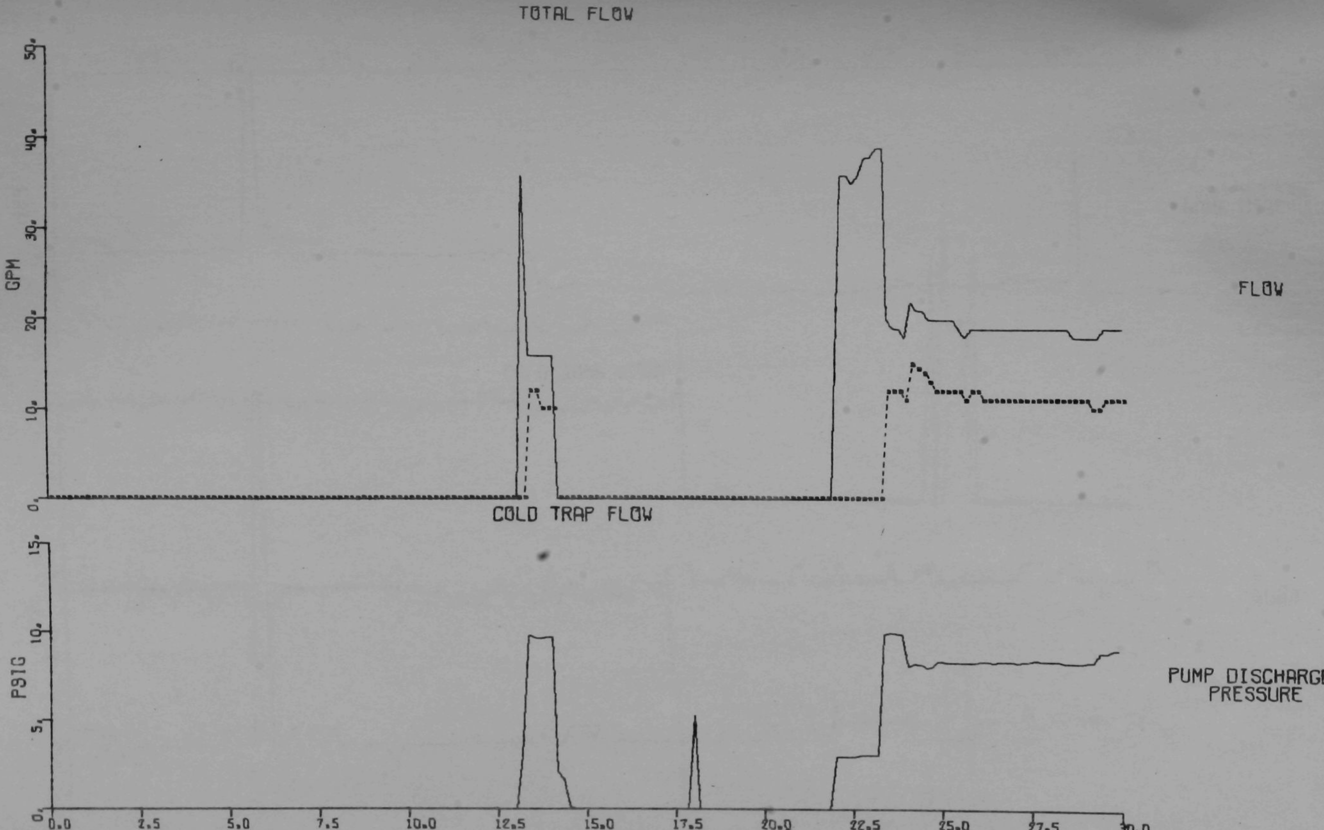
JUNE 1968 FIGURE 40



JUNE 1968 FIGURE 41

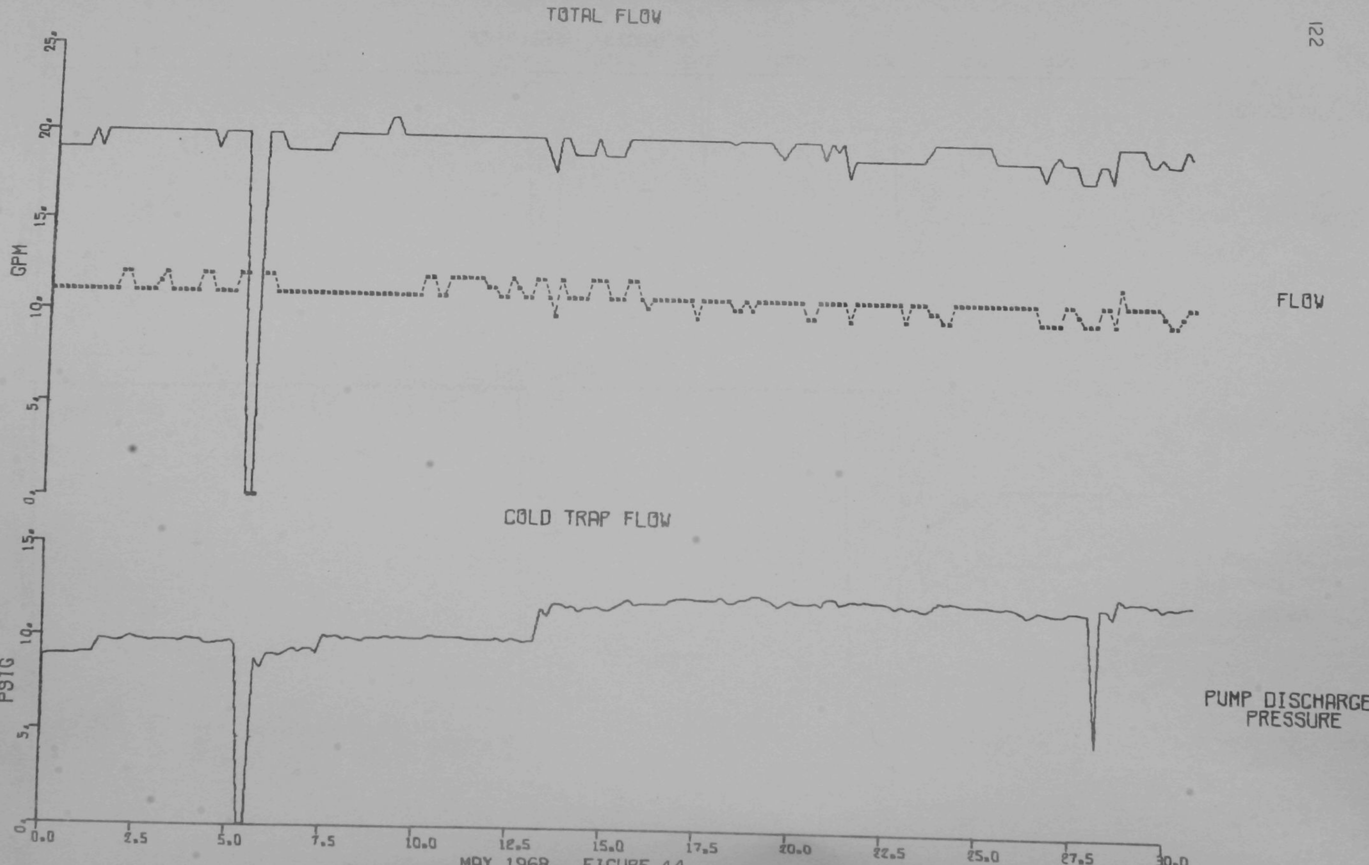


JUNE 1968 FIGURE 42



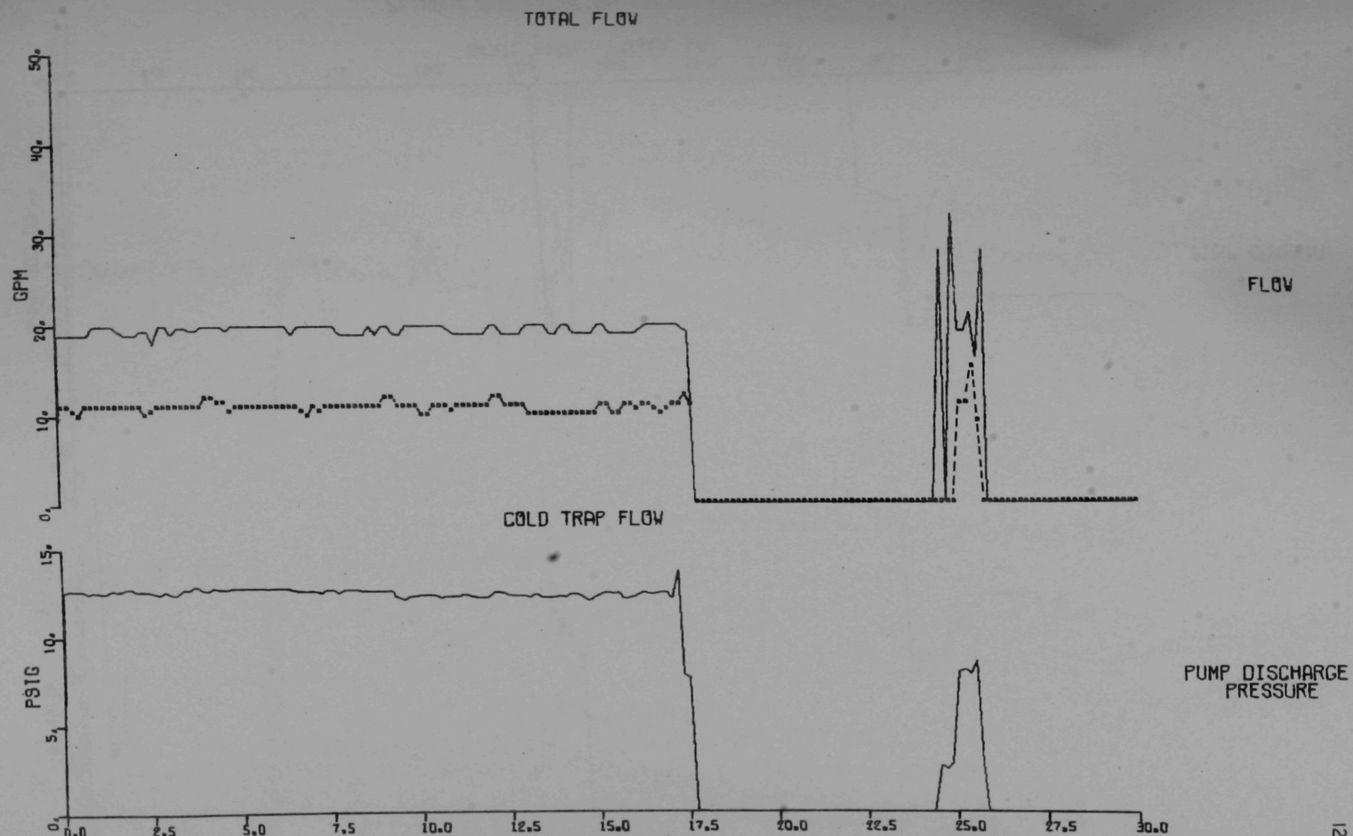
APRIL 1968 FIGURE 43

PRIMARY PURIFICATION SYSTEM PERFORMANCE



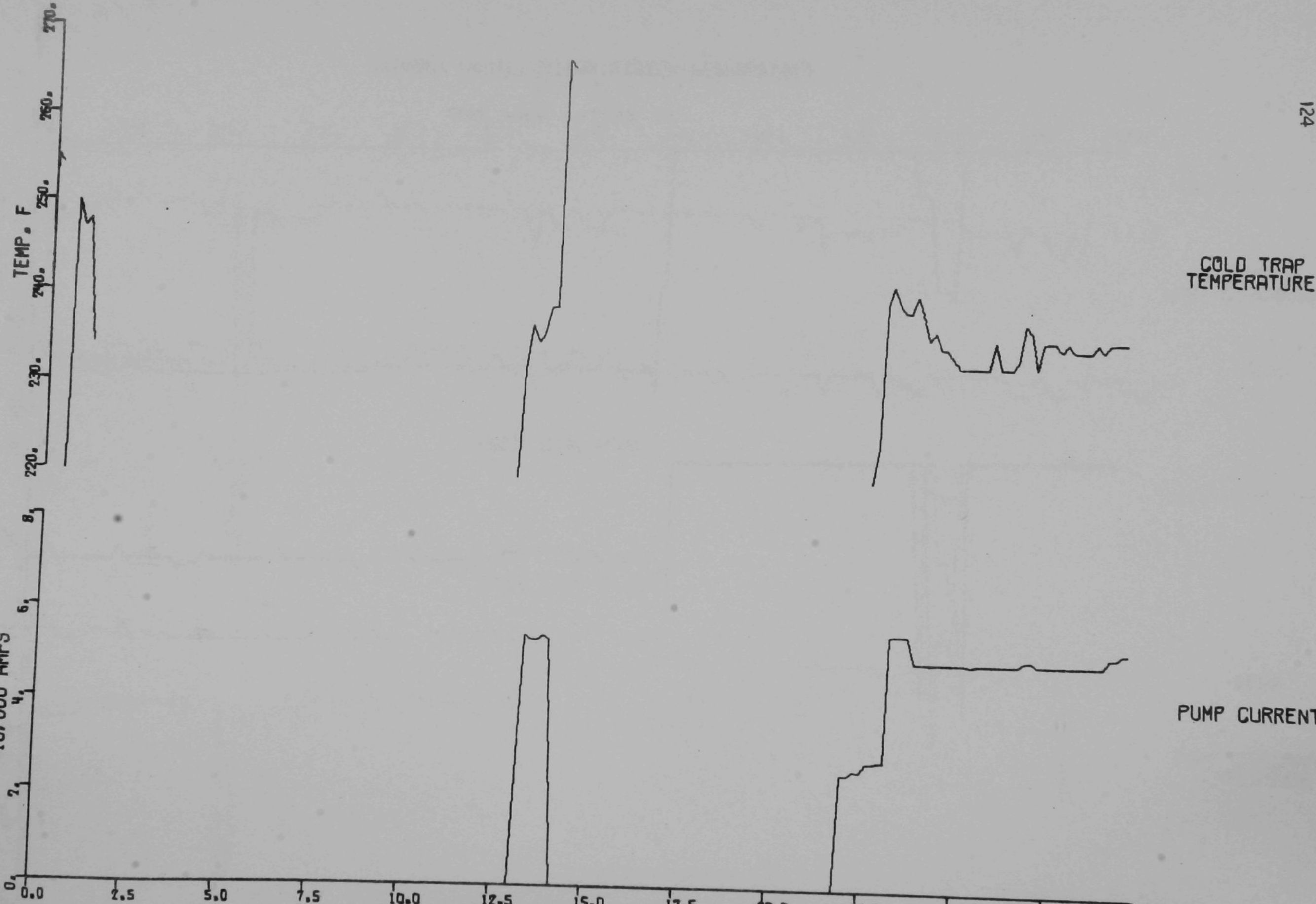
MAY 1968 FIGURE 44

PRIMARY PURIFICATION SYSTEM PERFORMANCE



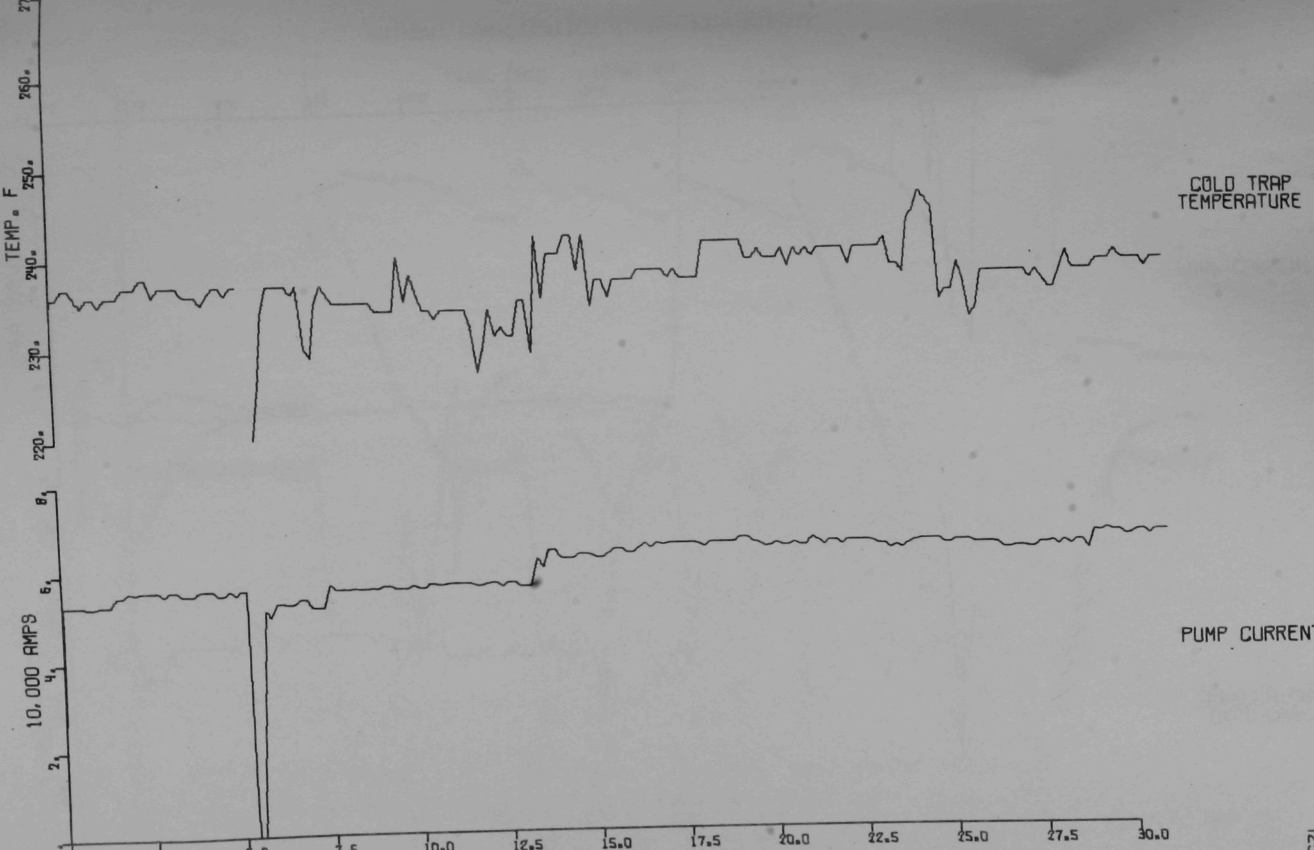
JUNE 1968 FIGURE 45

PRIMARY PURIFICATION SYSTEM PERFORMANCE



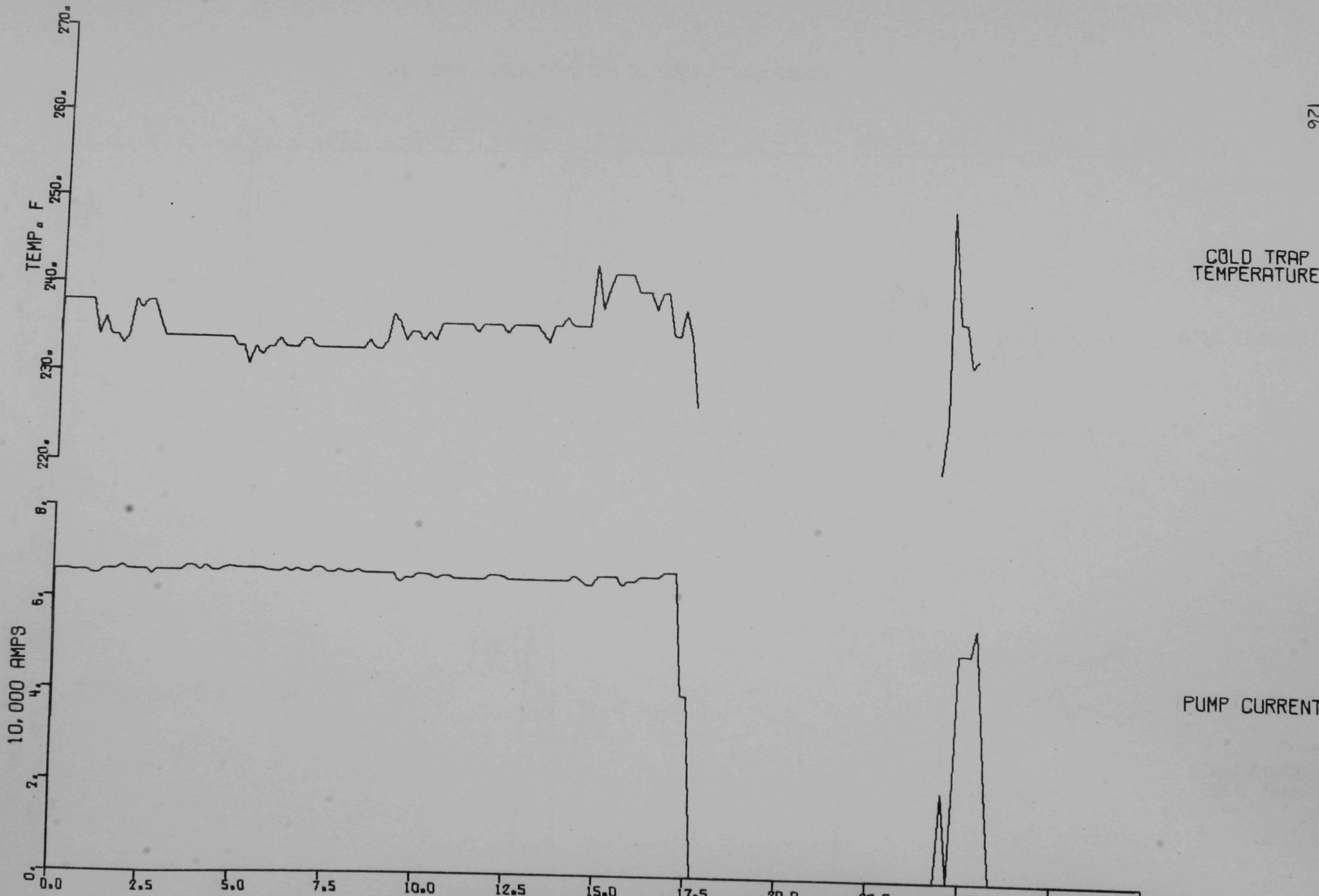
APRIL 1968 FIGURE 46

PRIMARY PURIFICATION SYSTEM PERFORMANCE



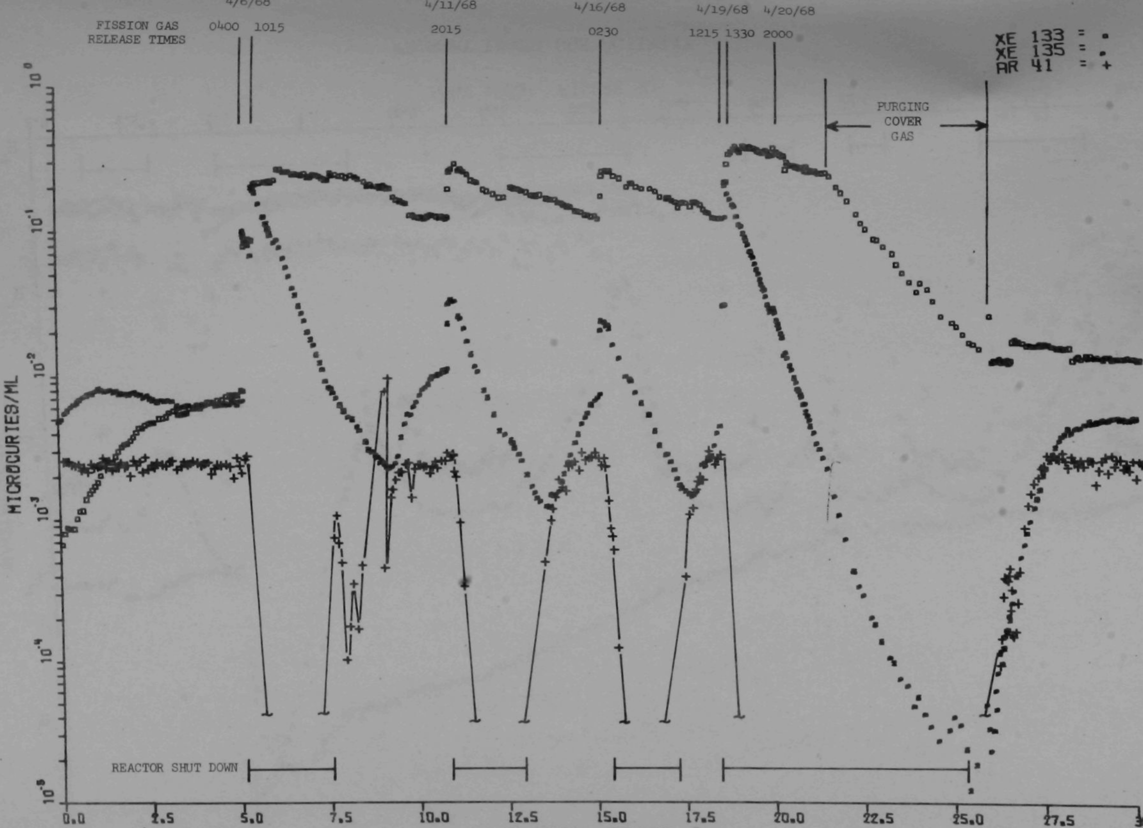
MAY 1968 FIGURE 47

PRIMARY PURIFICATION SYSTEM PERFORMANCE



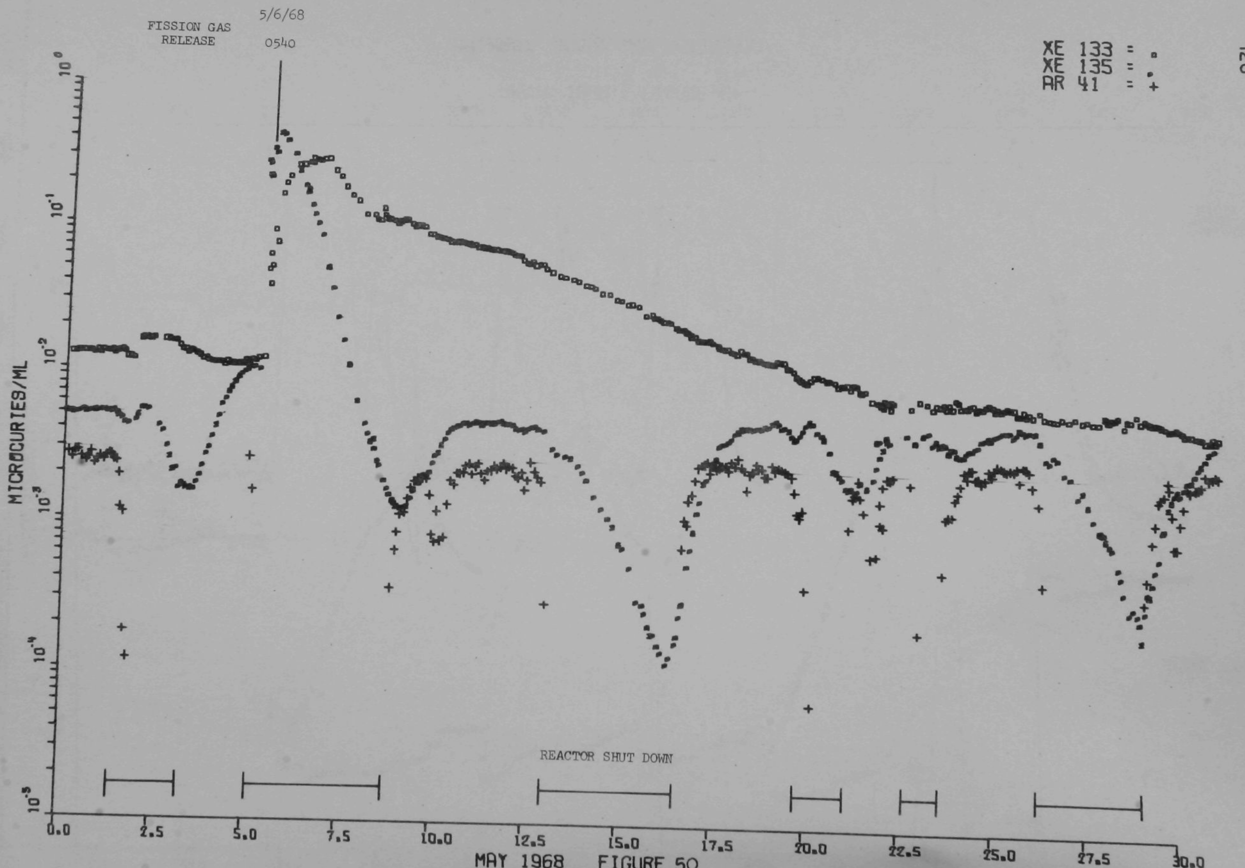
JUNE 1968 FIGURE 48

PRIMARY PURIFICATION SYSTEM PERFORMANCE



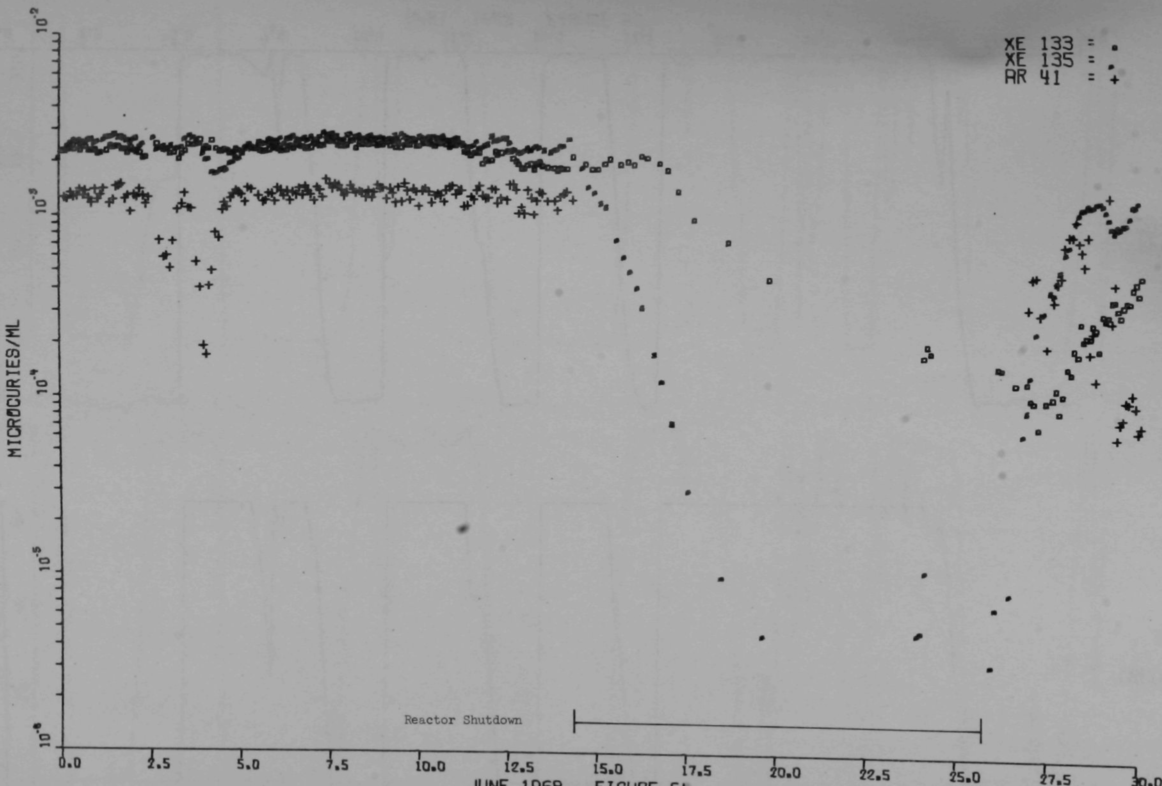
APRIL 1968 FIGURE 49

PRIMARY COVER GAS ACTIVITY



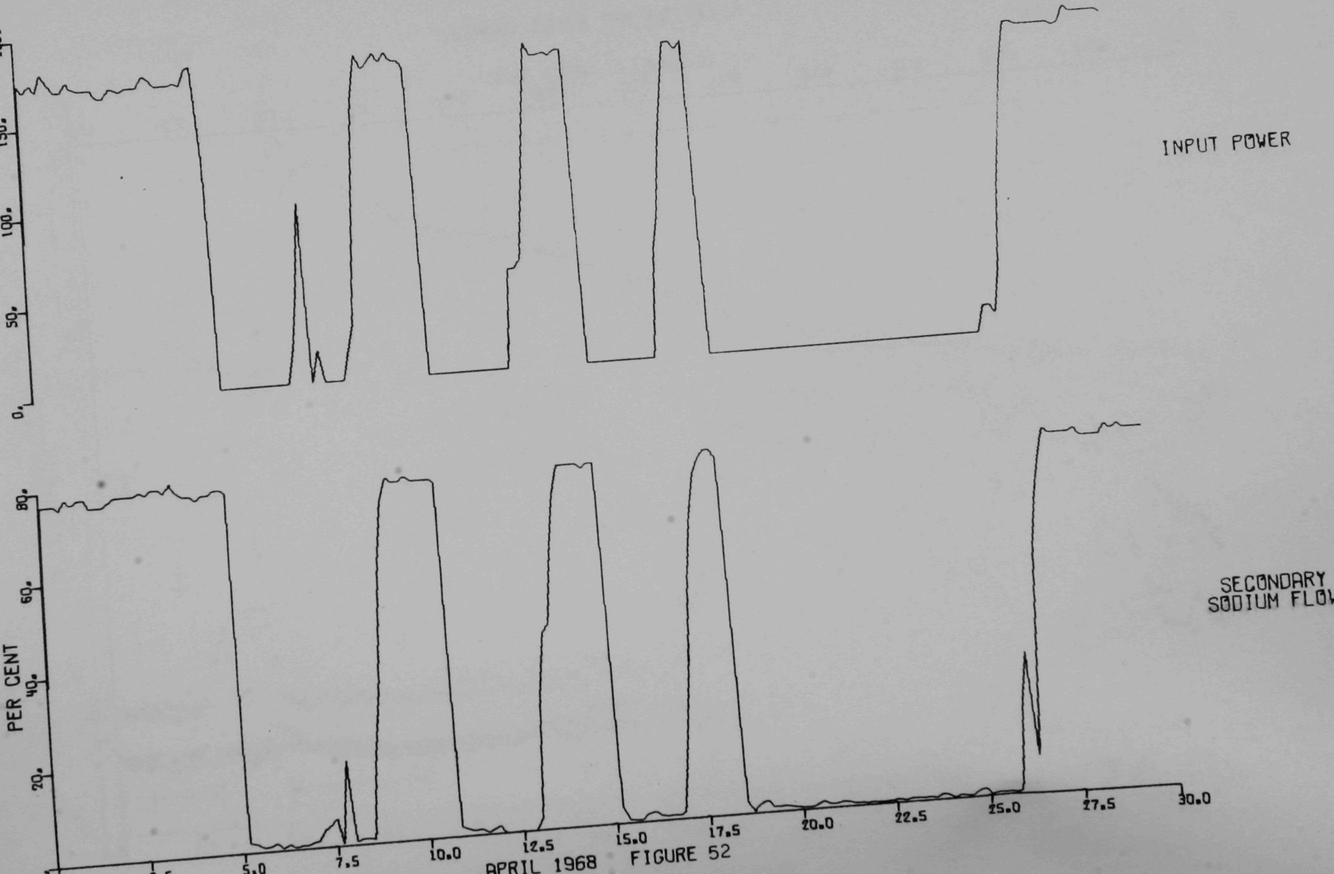
MAY 1968 FIGURE 50

PRIMARY COVER GAS ACTIVITY



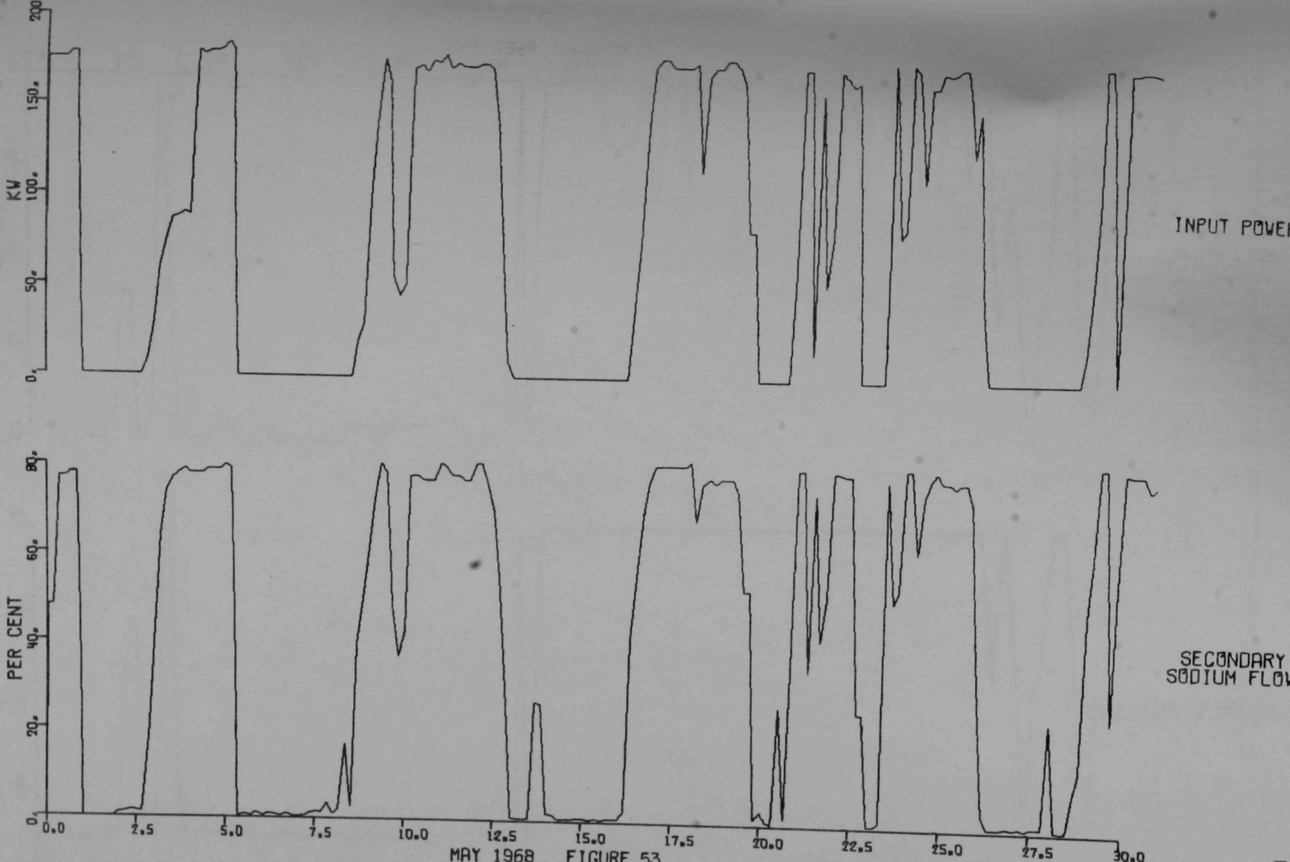
JUNE 1968 FIGURE 51

PRIMARY COVER GAS ACTIVITY



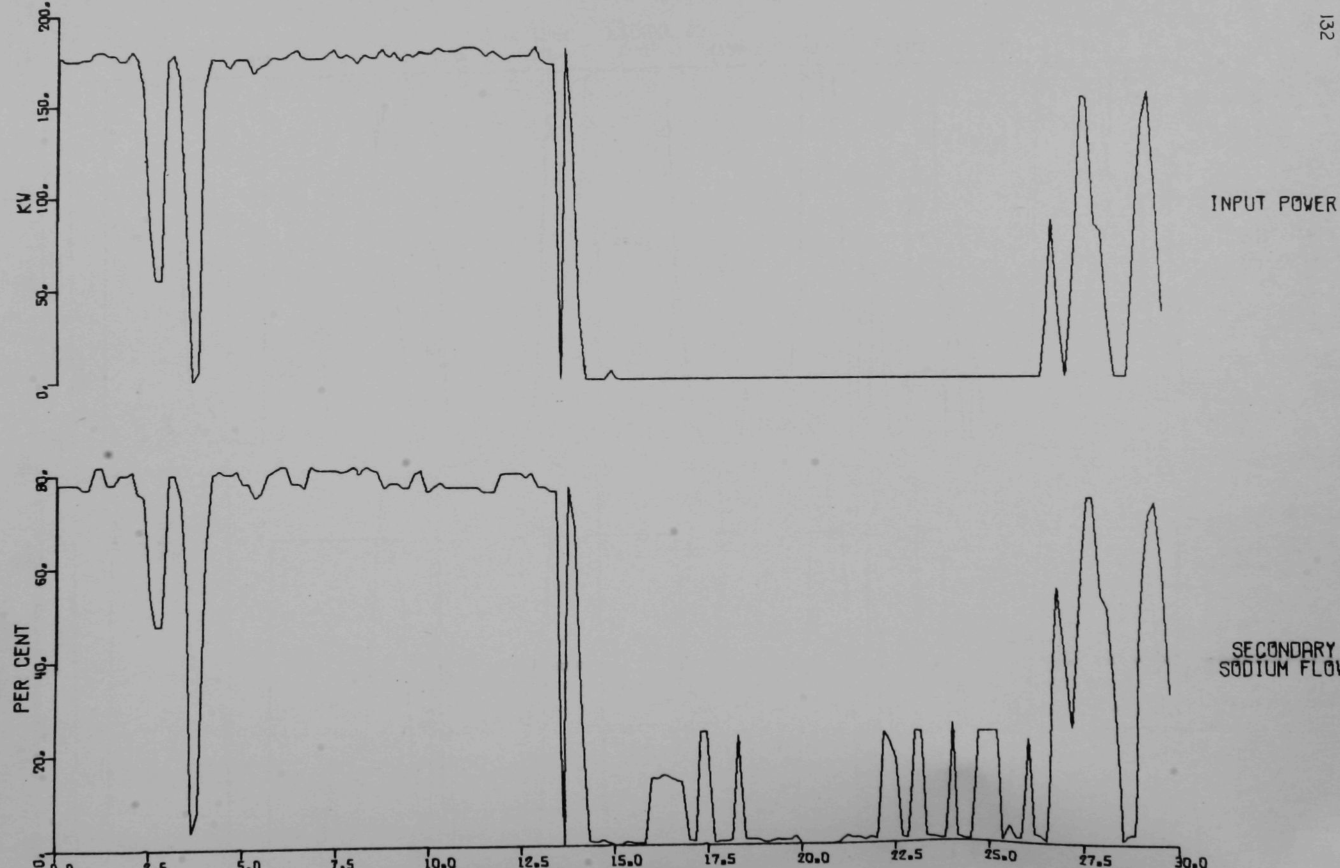
APRIL 1968 FIGURE 52

SECONDARY SODIUM PUMP PERFORMANCE



MAY 1968 FIGURE 53

SECONDARY SODIUM PUMP PERFORMANCE



JUNE 1968 FIGURE 54

SECONDARY SODIUM PUMP PERFORMANCE

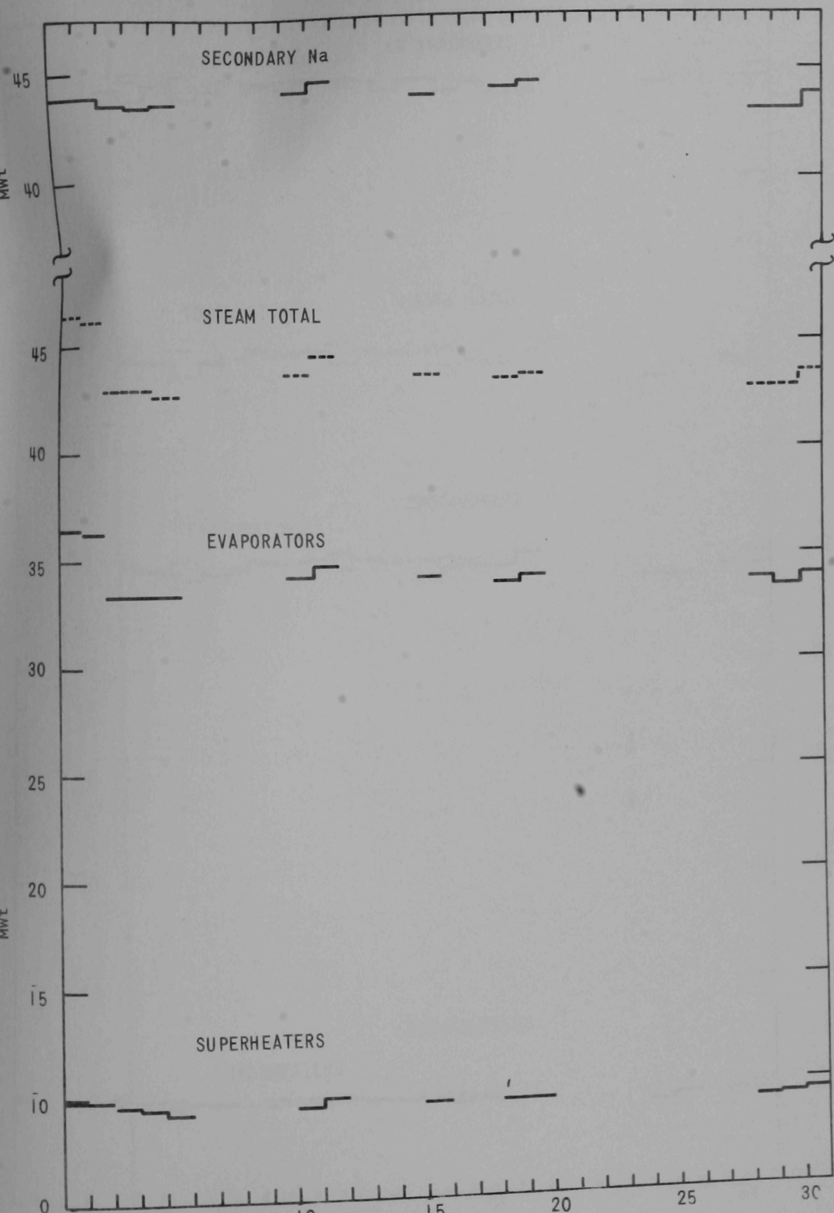


FIGURE 55
APRIL 1968

STEAM GENERATOR PERFORMANCE

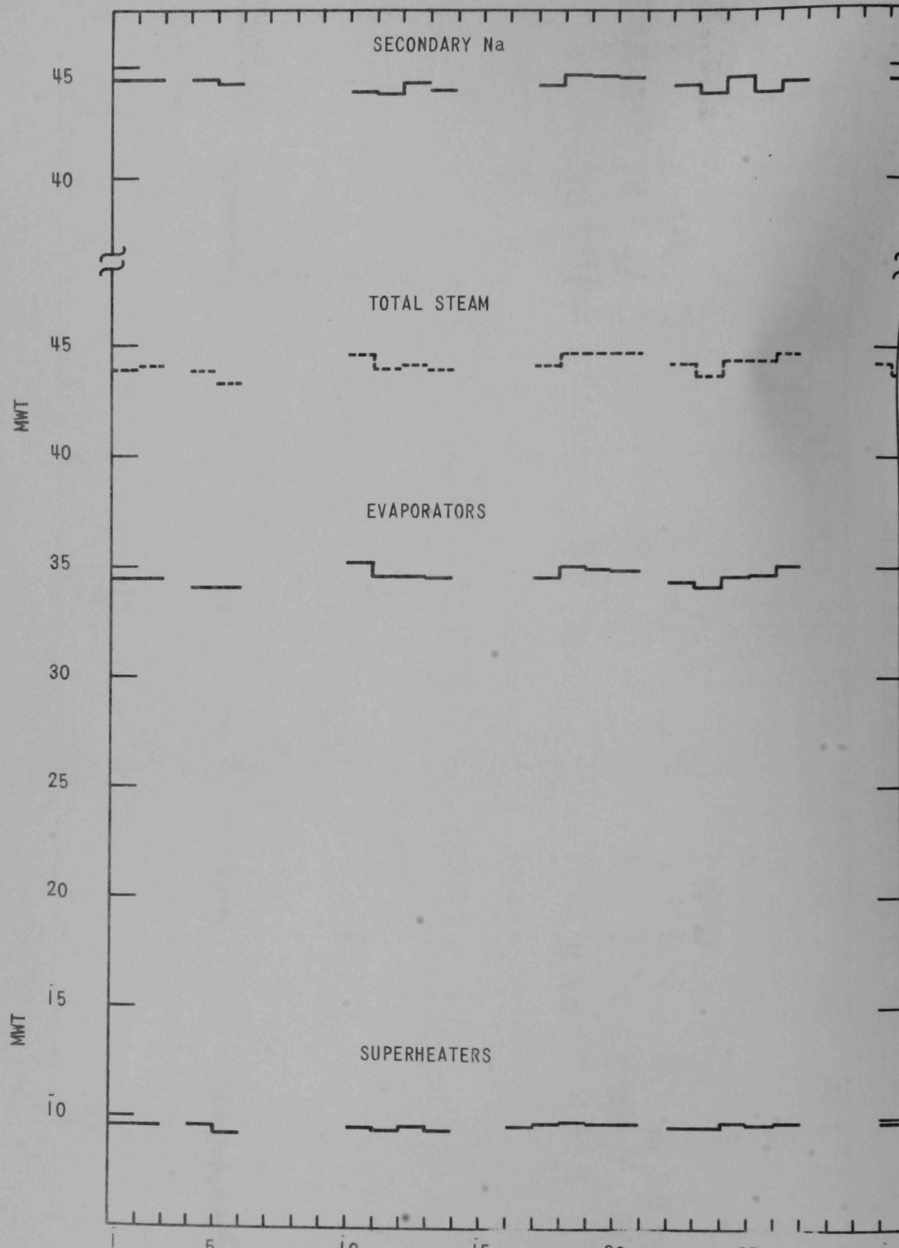


FIGURE 56
MAY 1968

STEAM GENERATOR PERFORMANCE

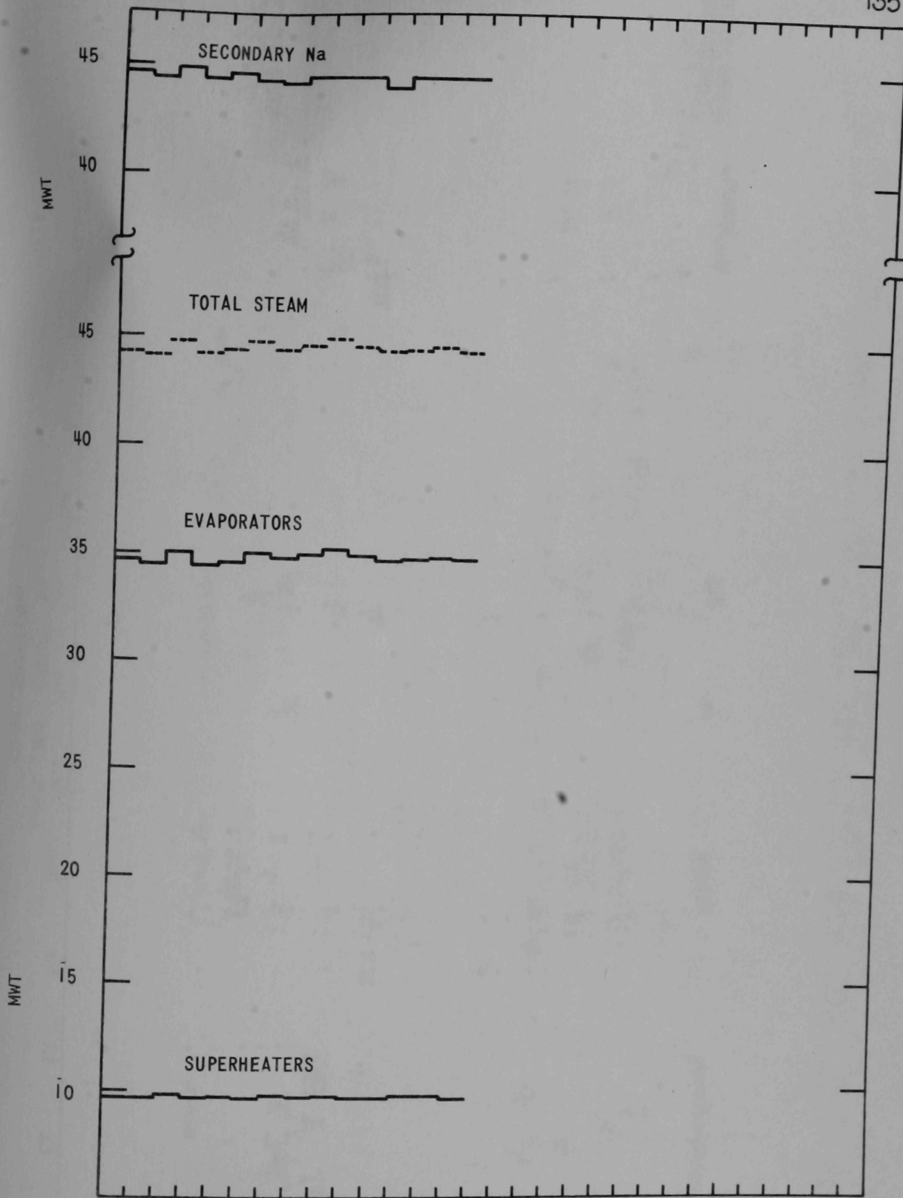
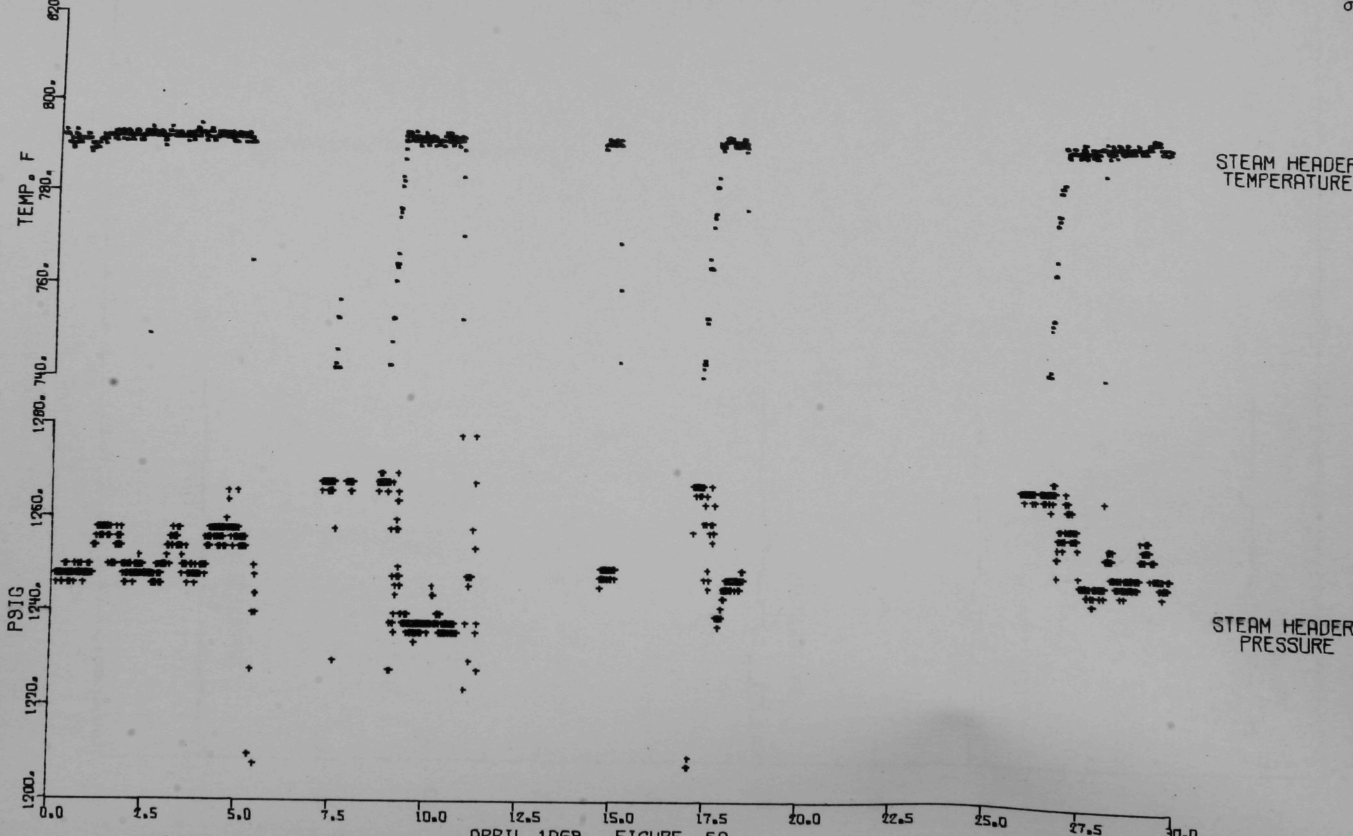


FIGURE 57

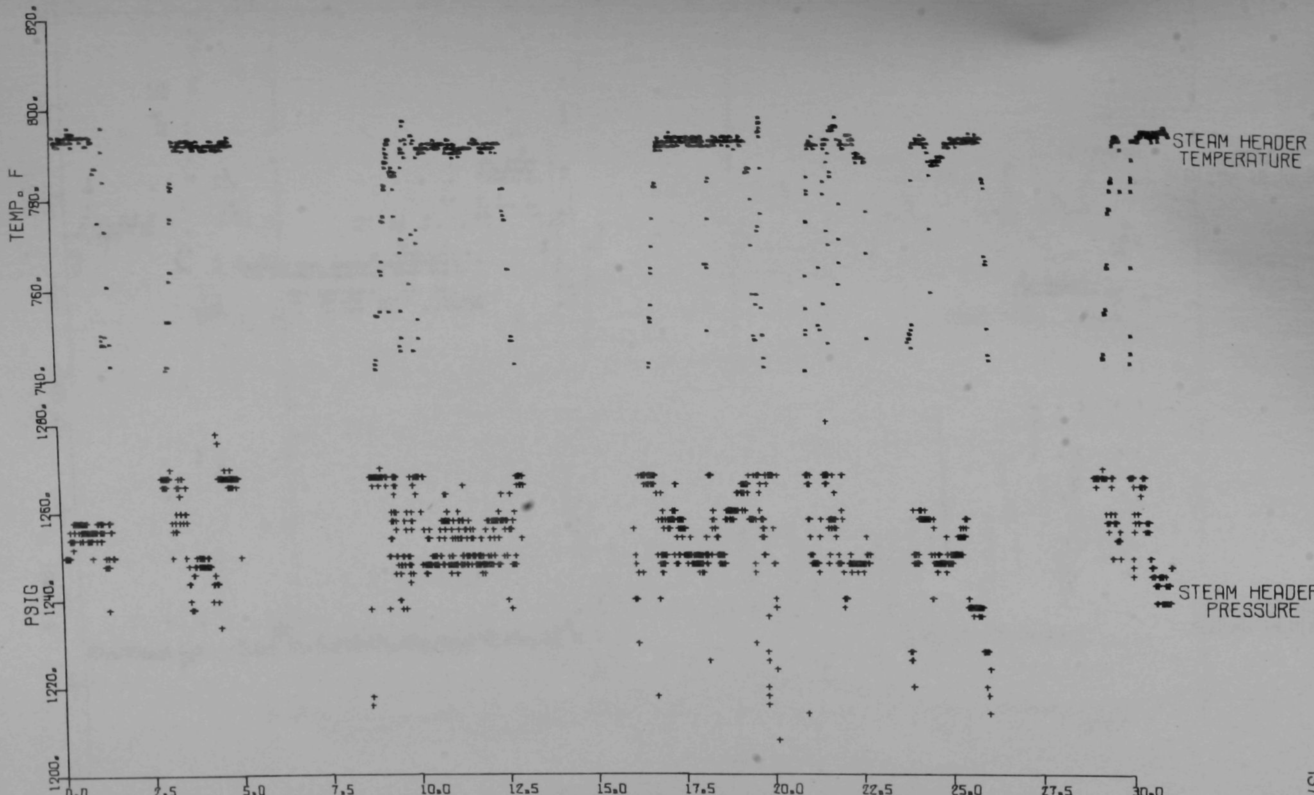
JUNE 1968

STEAM GENERATOR PERFORMANCE



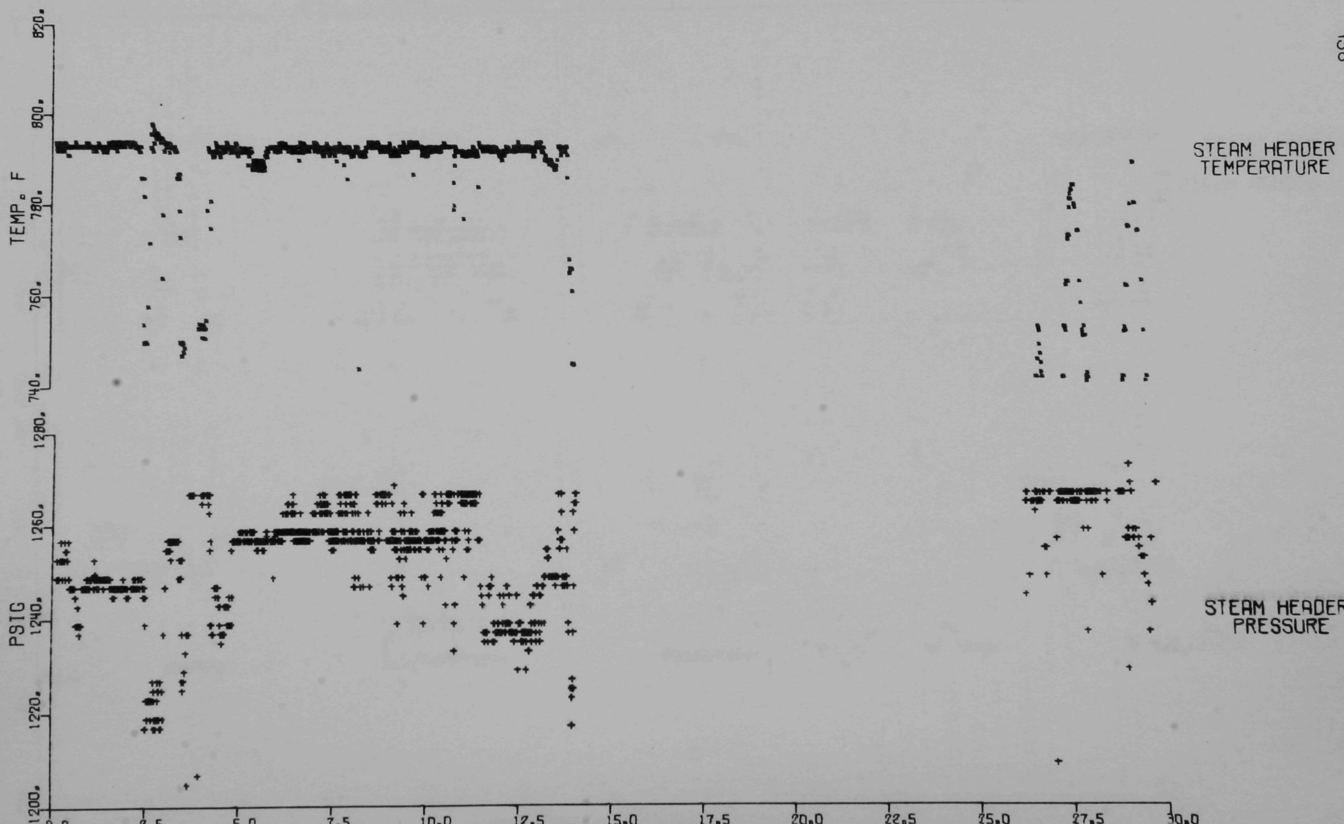
APRIL 1968 FIGURE 58

STEAM CONDITIONS



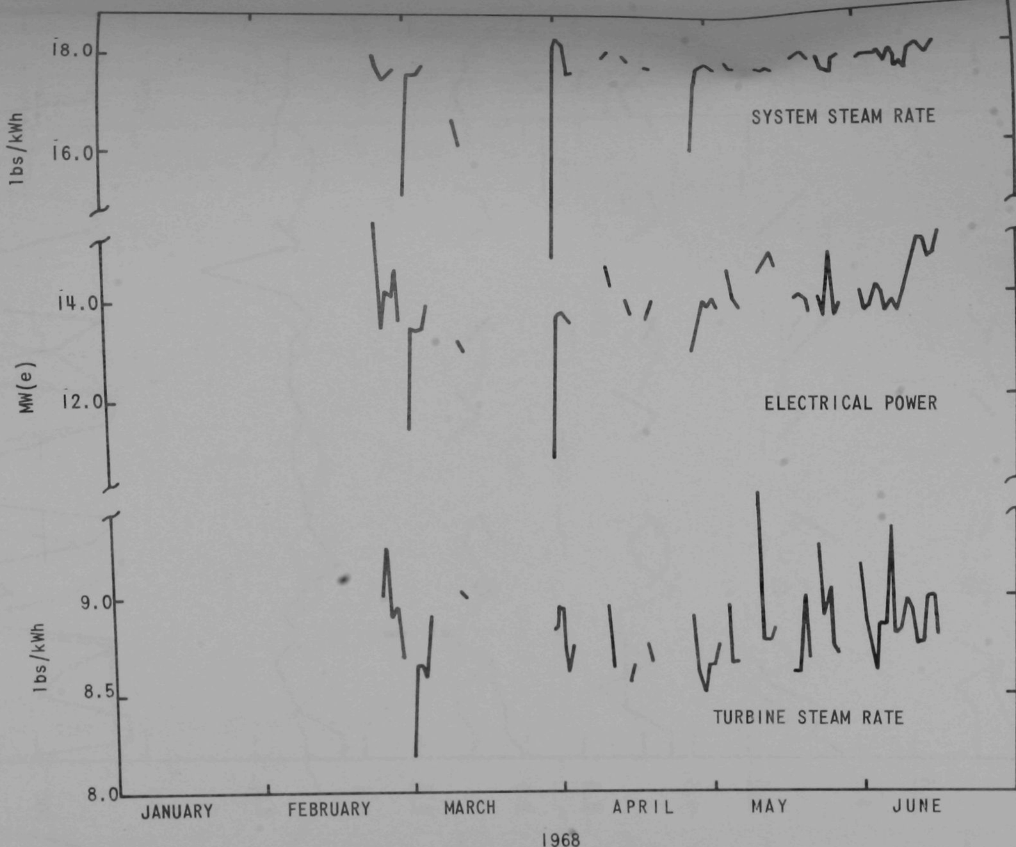
MAY 1968 FIGURE 59

STEAM CONDITIONS



JUNE 1968 FIGURE 60

STEAM CONDITIONS



TURBINE GENERATOR SYSTEM PERFORMANCE
FIGURE 61

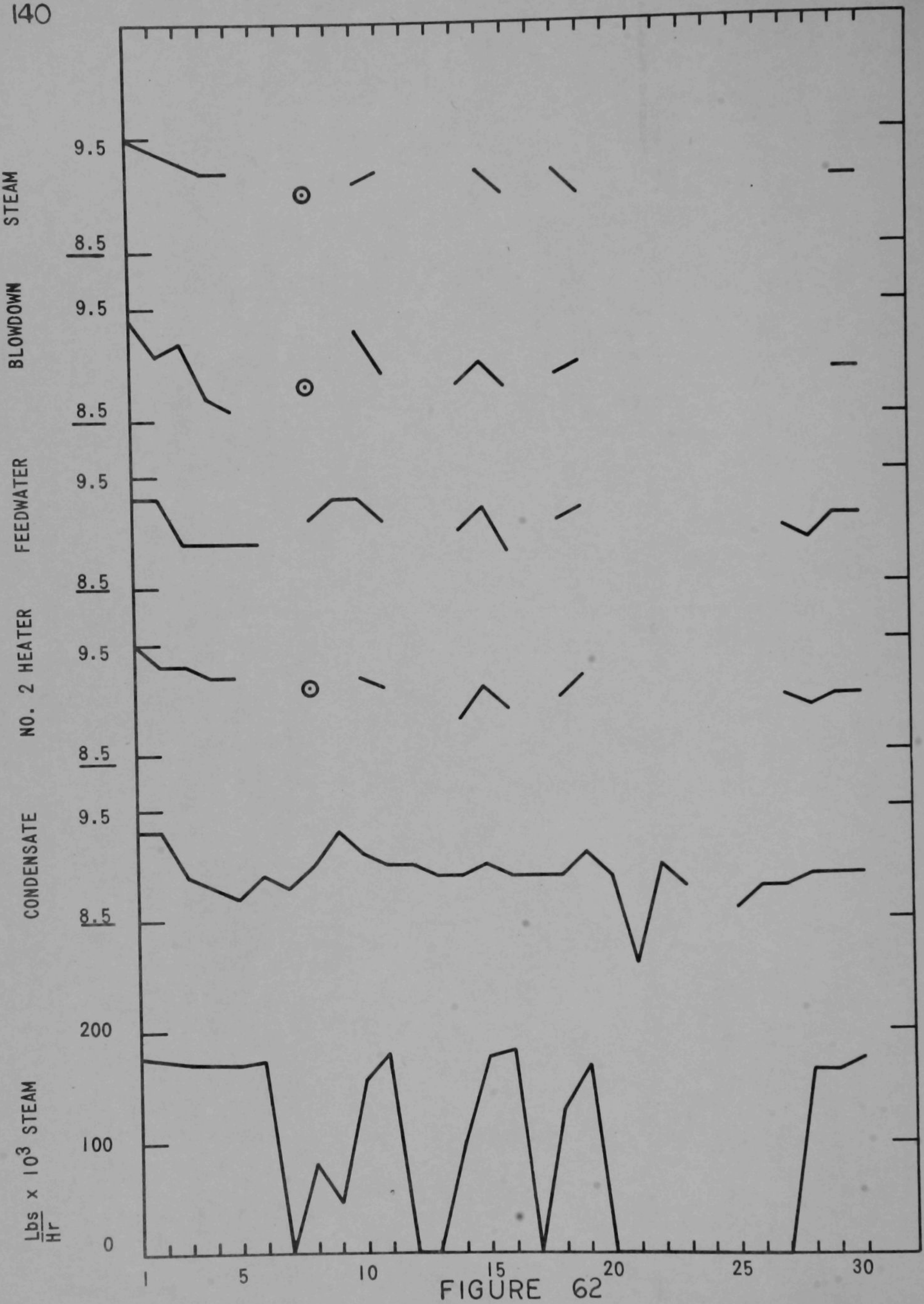


FIGURE 62

APRIL 1968

POWER CYCLE STREAMS, pH

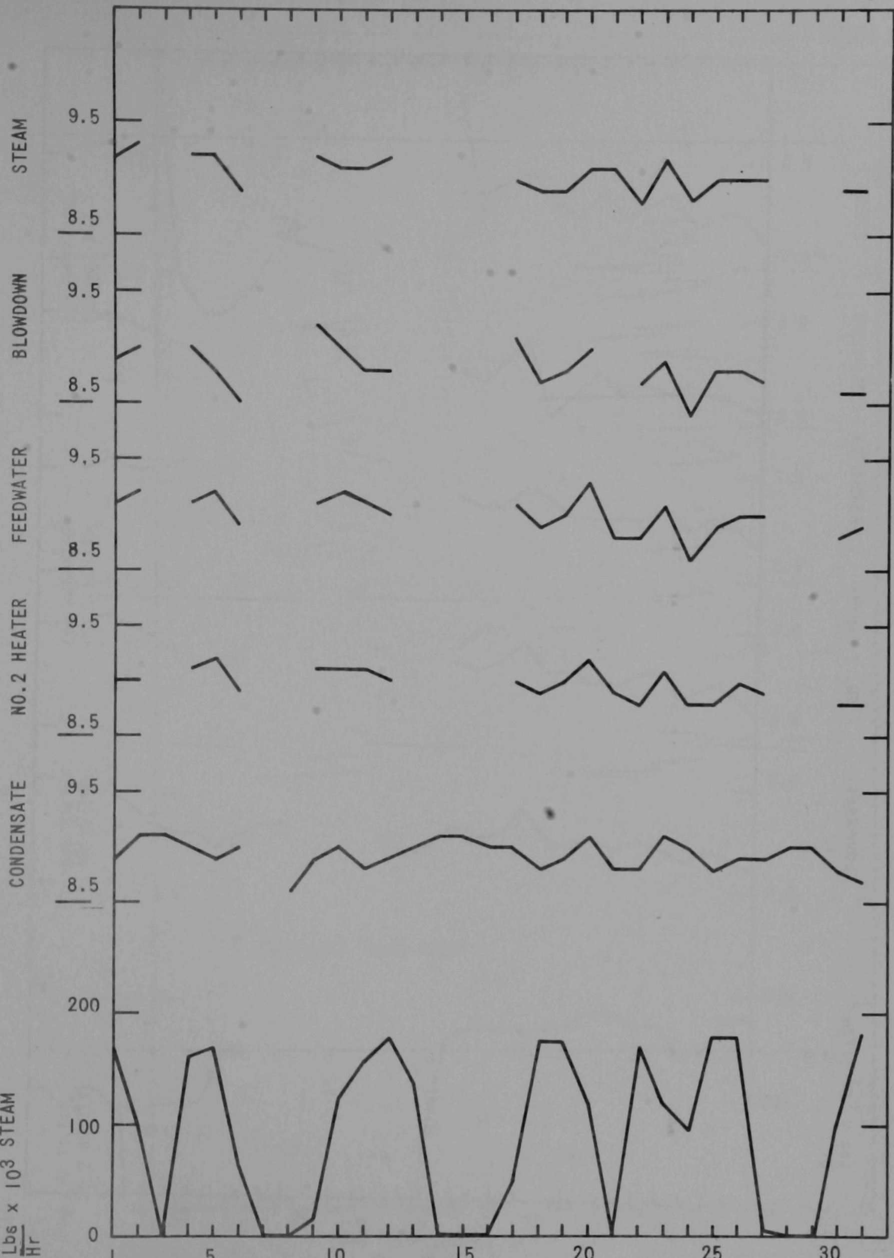


FIGURE 63

MAY 1968

POWER CYCLE STREAMS, pH

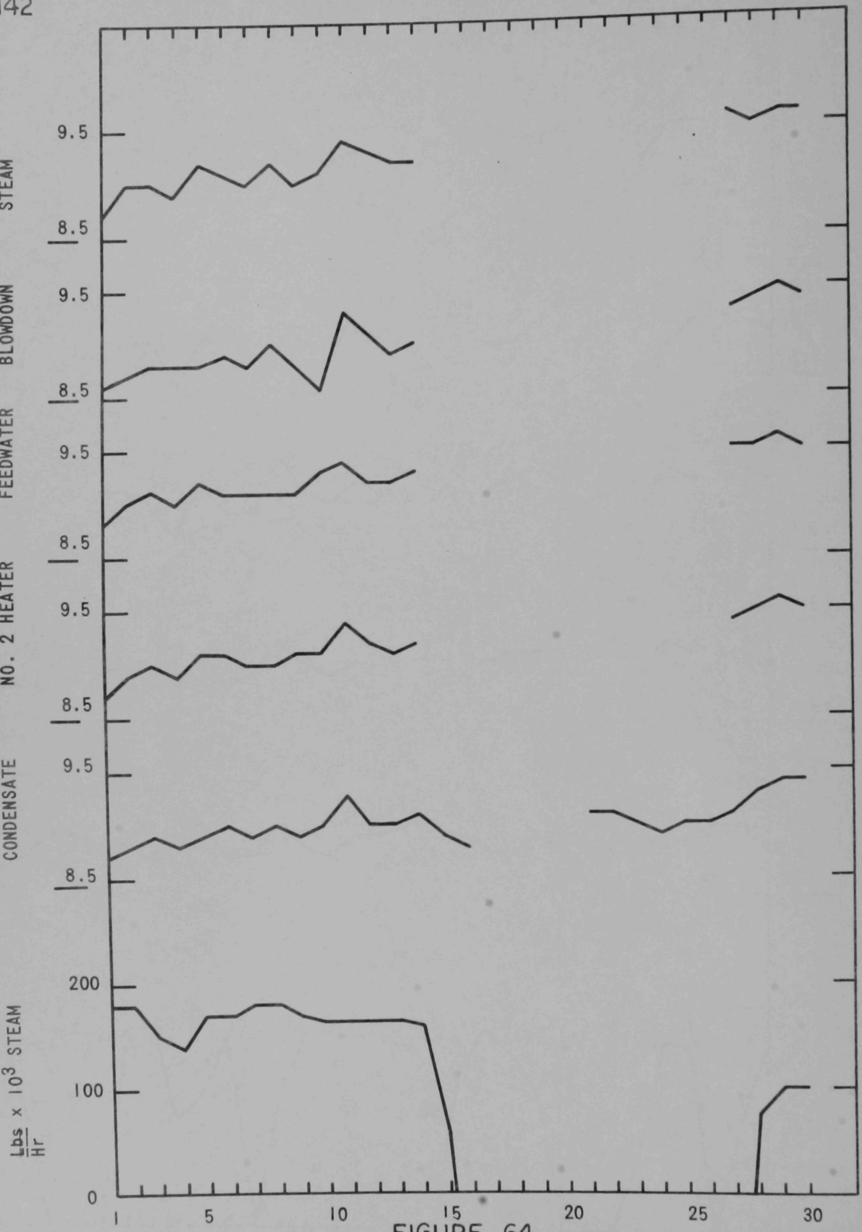


FIGURE 64
JUNE 1968

POWER CYCLE STREAMS: pH

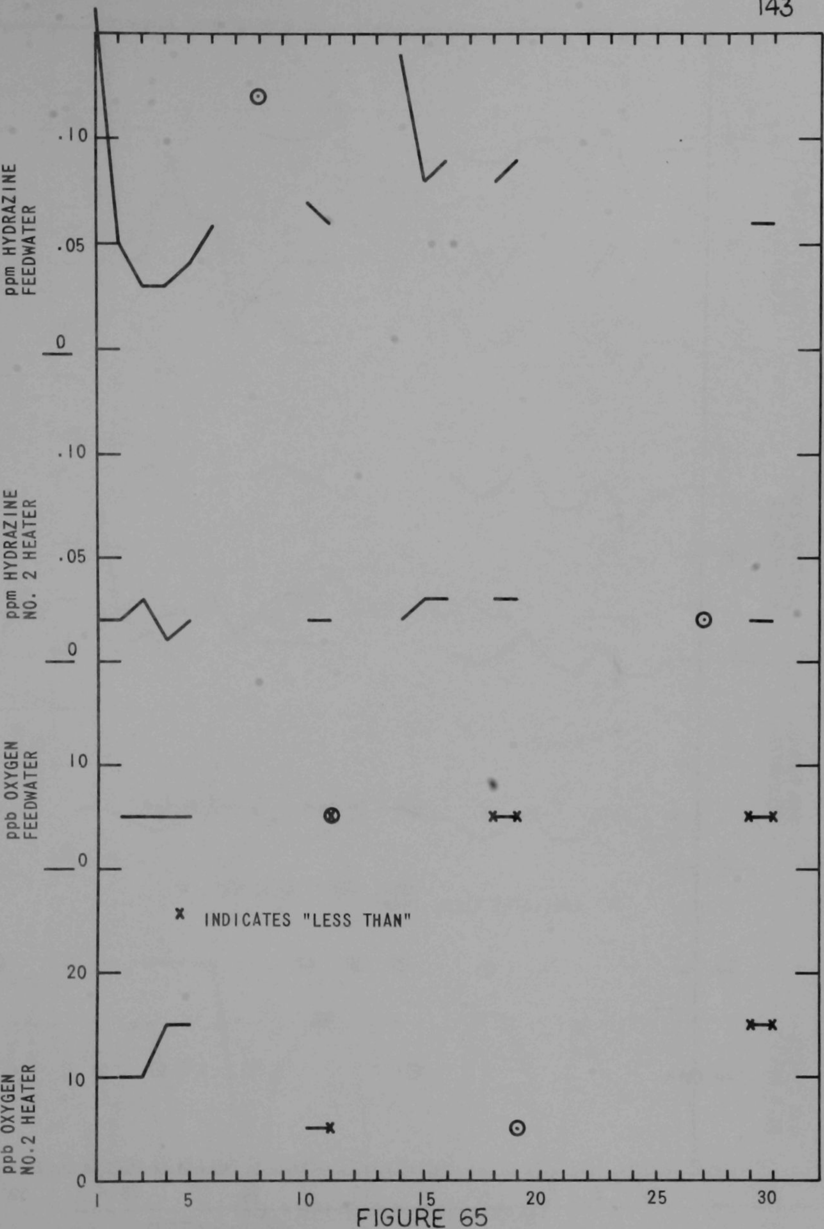
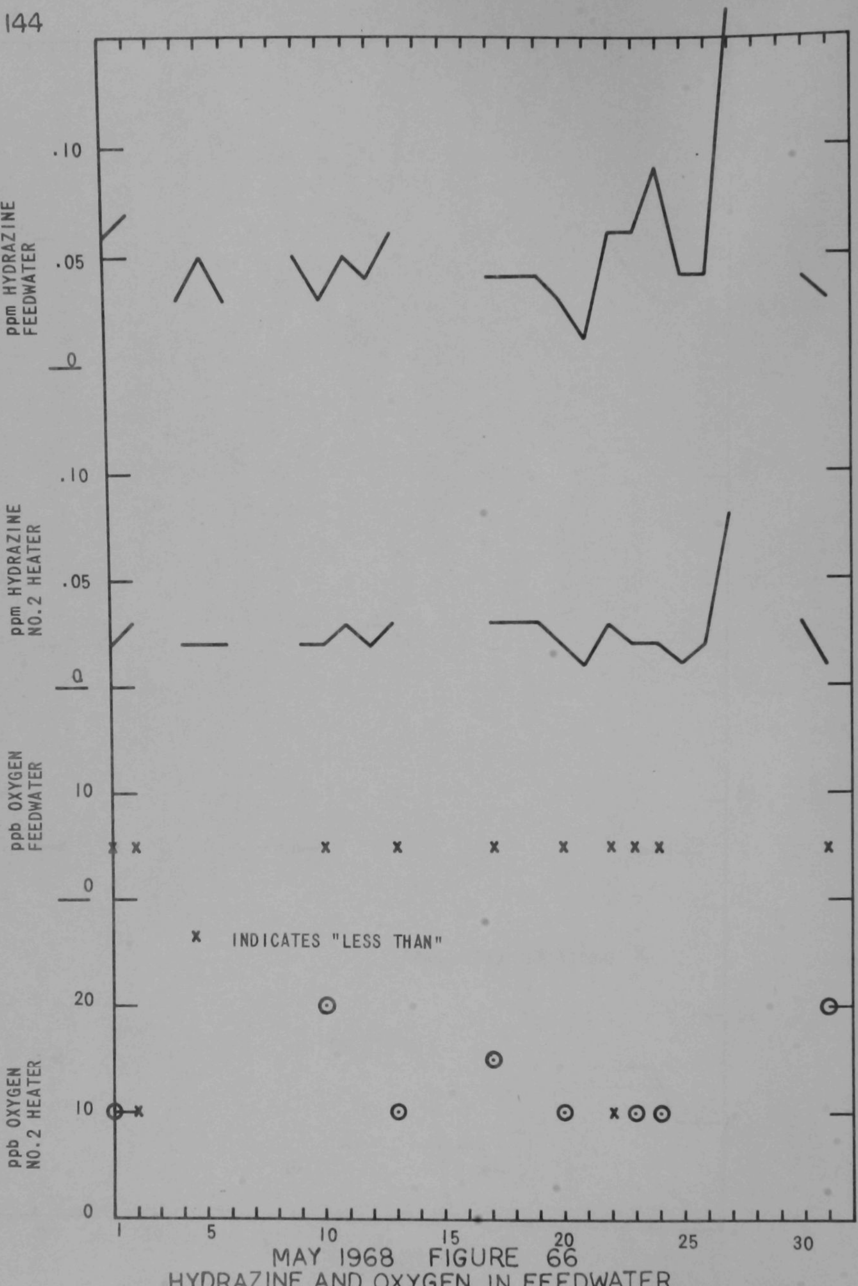
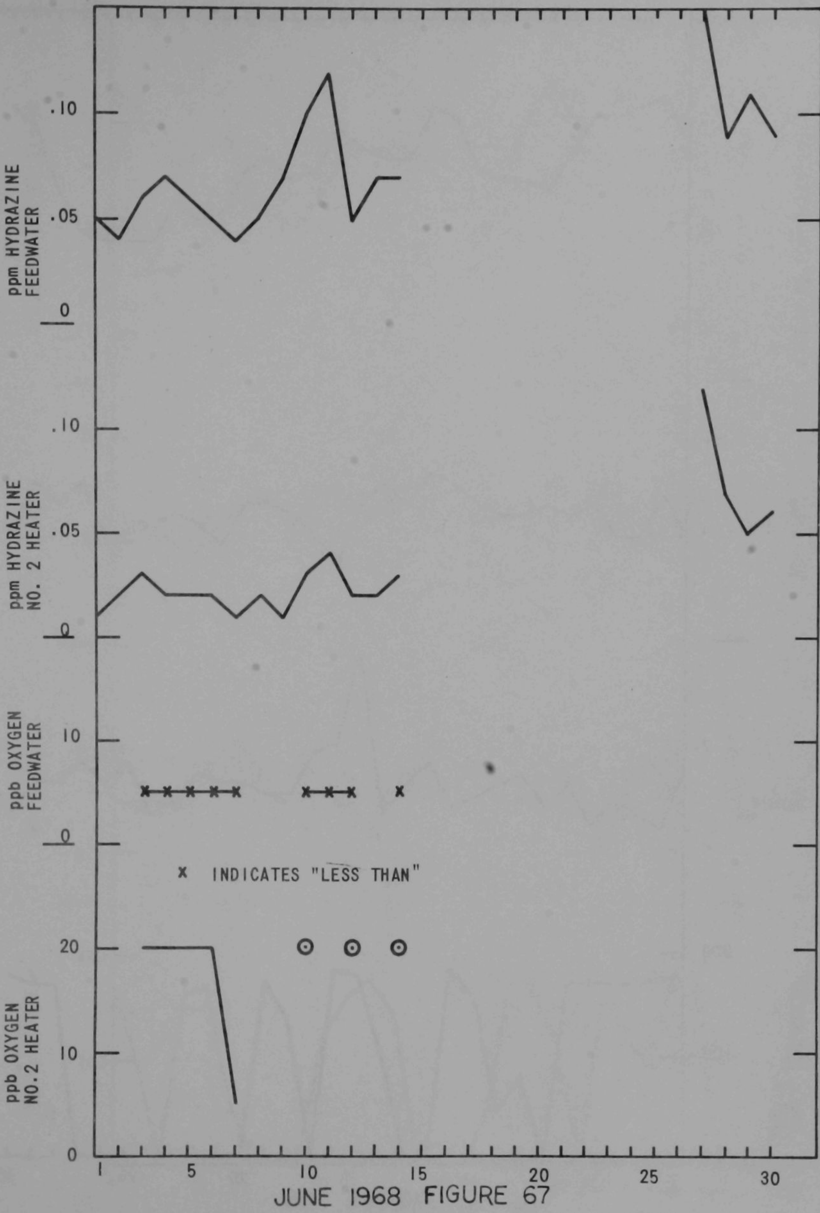


FIGURE 65
APRIL 1968
HYDRAZINE AND OXYGEN IN FEEDWATER AND HEATER NO. 2



MAY 1968 FIGURE 66
HYDRAZINE AND OXYGEN IN FEEDWATER AND HEATER NO. 2



JUNE 1968 FIGURE 67
HYDRAZINE AND OXYGEN IN FEEDWATER
AND HEATER NO. 2

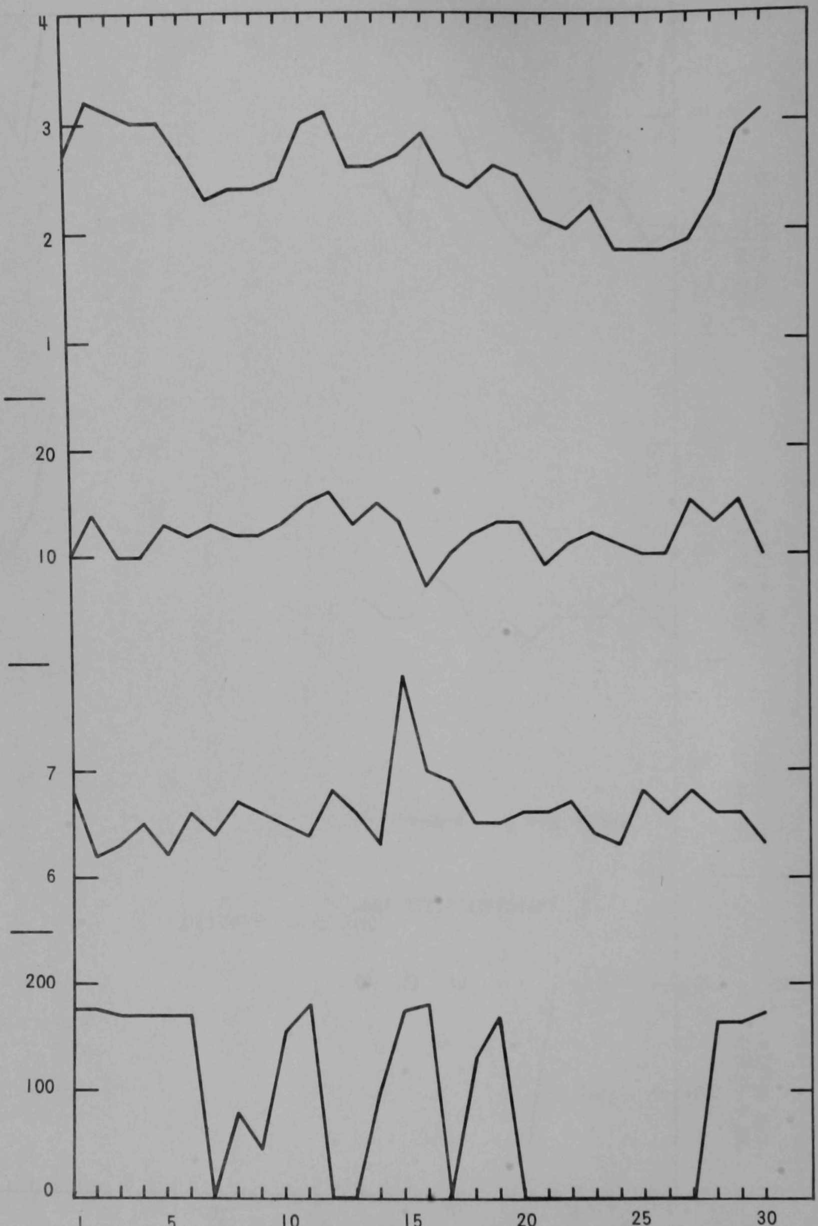


FIGURE 68

APRIL 1968

CONDENSER COOLING WATER pH AND C_rO_4

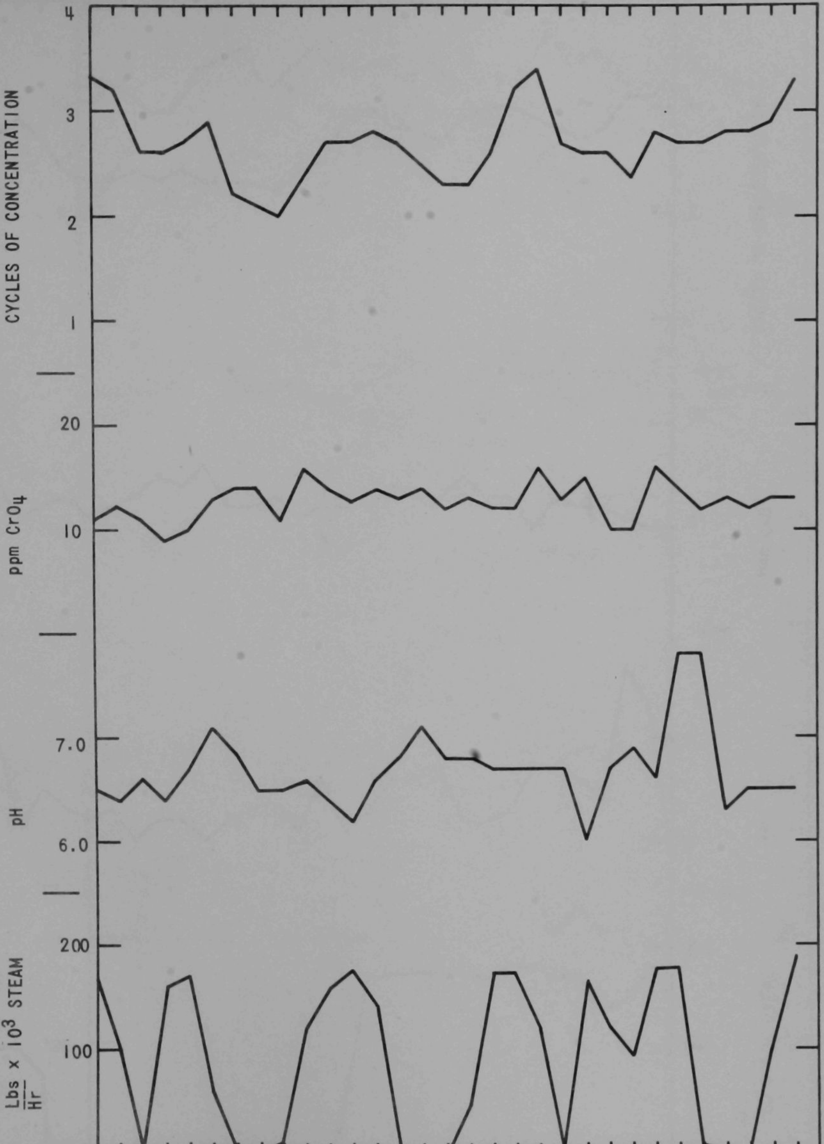


FIGURE 69
MAY 1968
CONDENSER COOLING WATER pH AND CrO_4

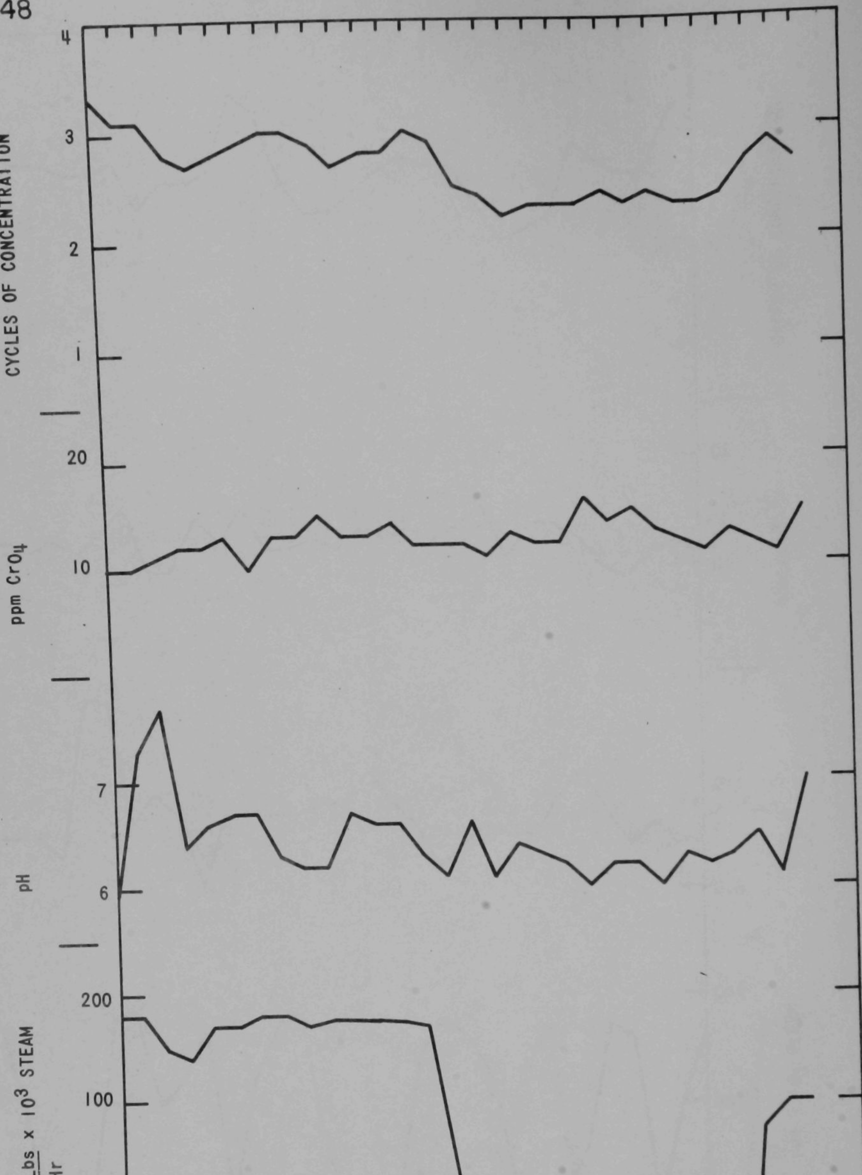


FIGURE 70

JUNE 1968

CONDENSER COOLING WATER pH AND CrO_4

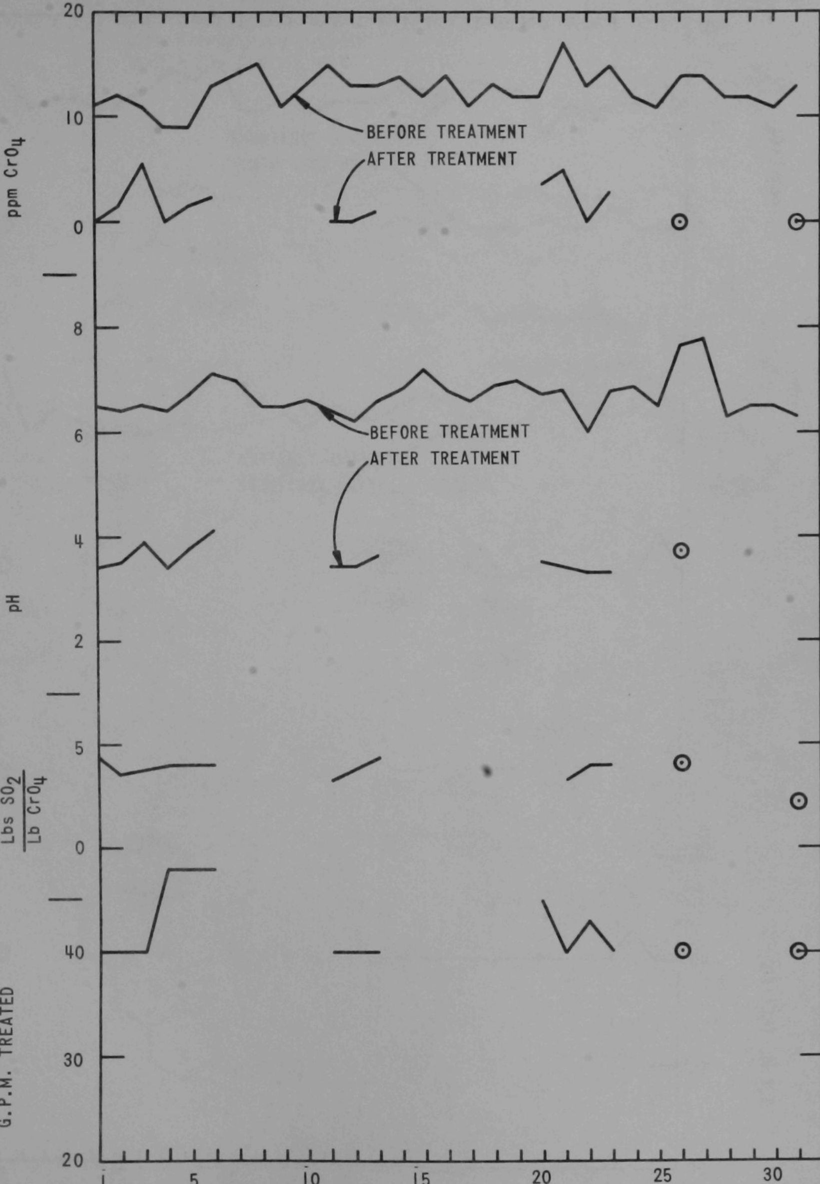


FIGURE 71
MAY 1968
CHROMATE REDUCTION

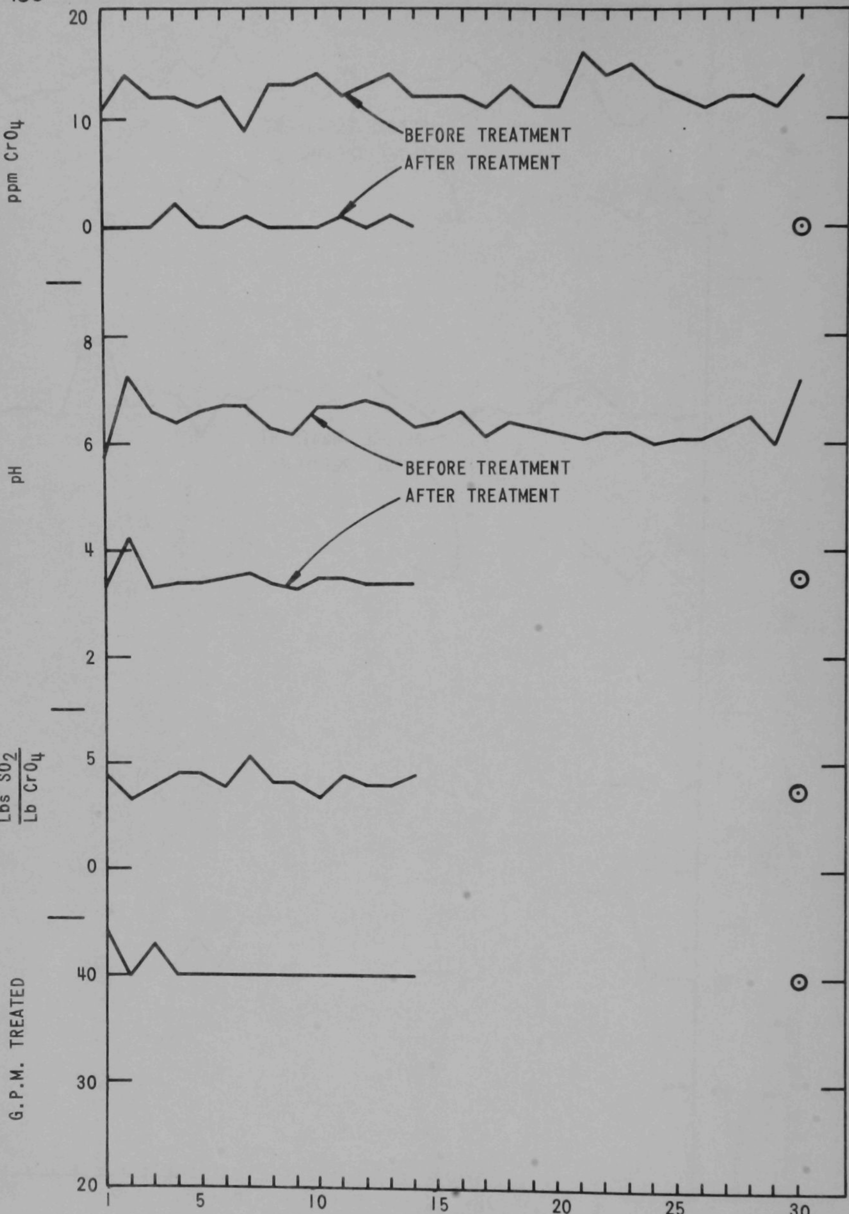


FIGURE 72

JUNE 1968

CHROMATE REDUCTION

KEY: SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE
SSCR - SST CONTROL ROD
C* - CONTROL ROD
S* - SAFETY ROD
D - DRIVER FUEL
P - ½ DRIVER FUEL, ½ SST
B - DEPLETED URANIUM
R - SST REFLECTOR

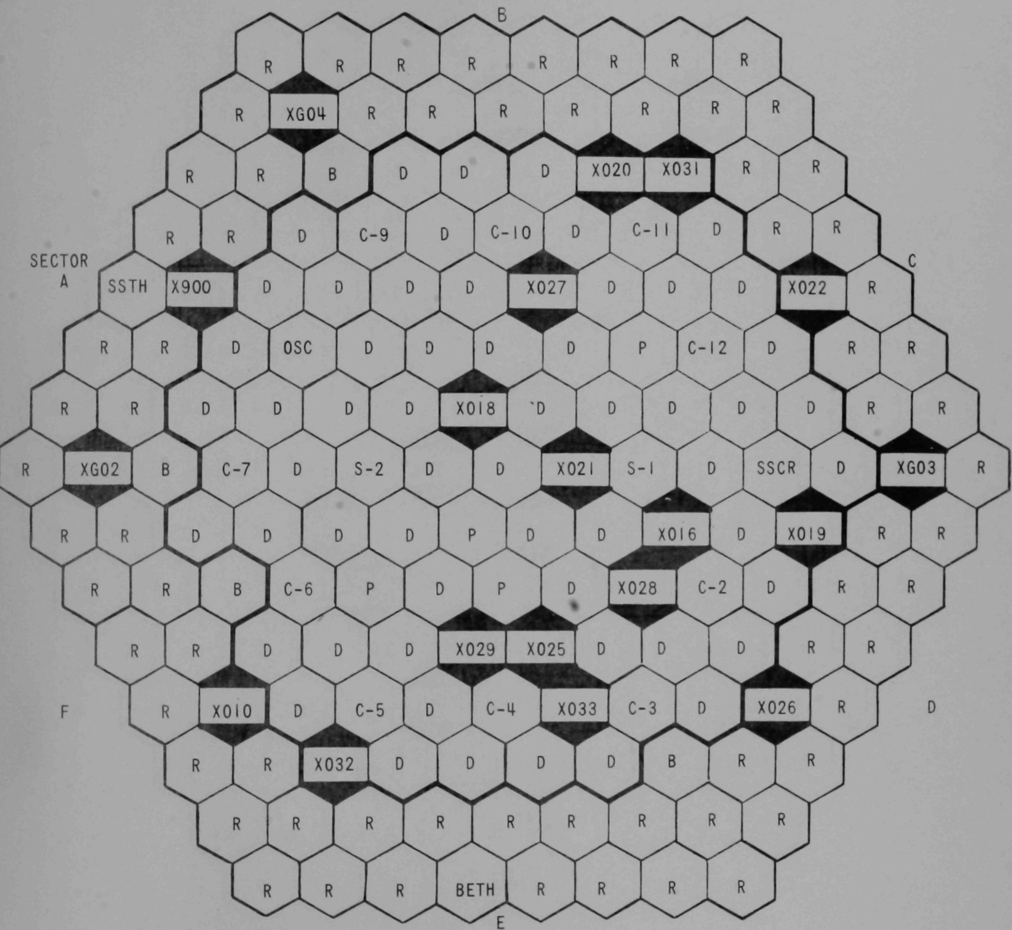


FIGURE 73
EBR-II LOADING PATTERN
RUN 27(E) FROM 4-7-68 TO 4-11-68

KEY: SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE
SSCR - SST CONTROL ROD

C* - CONTROL ROD
S* - SAFETY ROD
D - DRIVER FUEL
P - $\frac{1}{2}$ DRIVER FUEL, $\frac{1}{2}$ SST
B - DEPLETED URANIUM
R - SST REFLECTOR

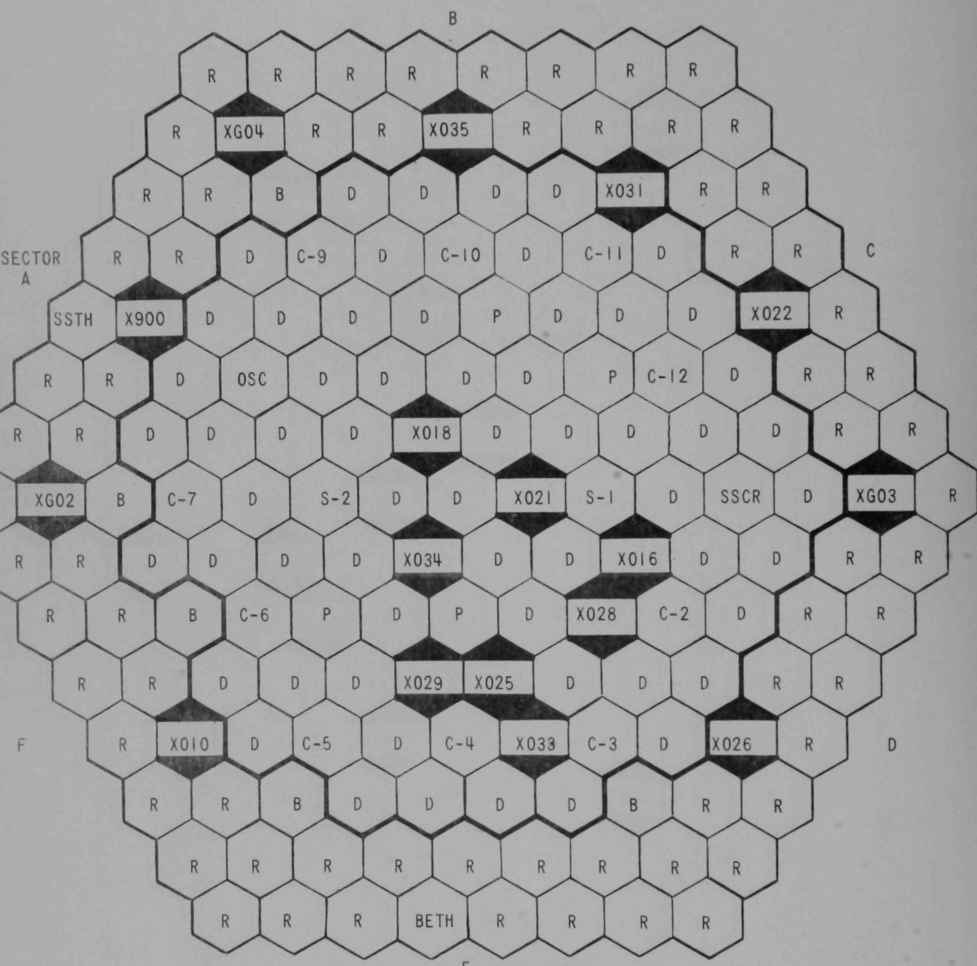


FIGURE 74
EBR-II LOADING PATTERN

RUN 27 (F) FROM 4-13-68 TO 4-16-68

KEY: SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE
SSCR - SST CONTROL ROD

C# - CONTROL ROD
S# - SAFETY ROD
D - DRIVER FUEL
P - $\frac{1}{2}$ DRIVER FUEL, $\frac{1}{2}$ SST
B - DEPLETED URANIUM
R - SST REFLECTOR

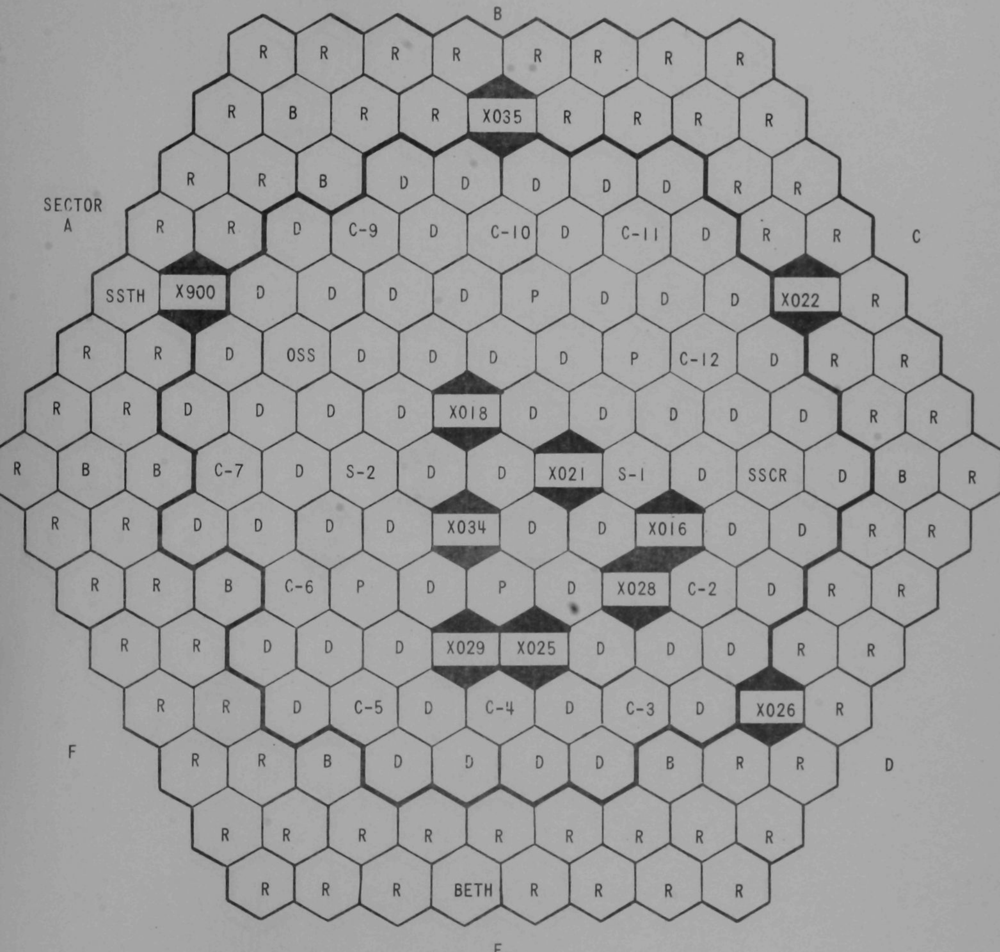


FIGURE 75
EBR-II LOADING PATTERN
RUN 27 (G) FROM 4-17-68 TO 4-19-68

KEY: SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE
SSCR - SST CONTROL ROD

C# - CONTROL ROD
S# - SAFETY ROD
D - DRIVER FUEL
P - $\frac{1}{2}$ DRIVER FUEL, $\frac{1}{2}$ SST
B - DEPLETED URANIUM
R - SST.REFLECTOR

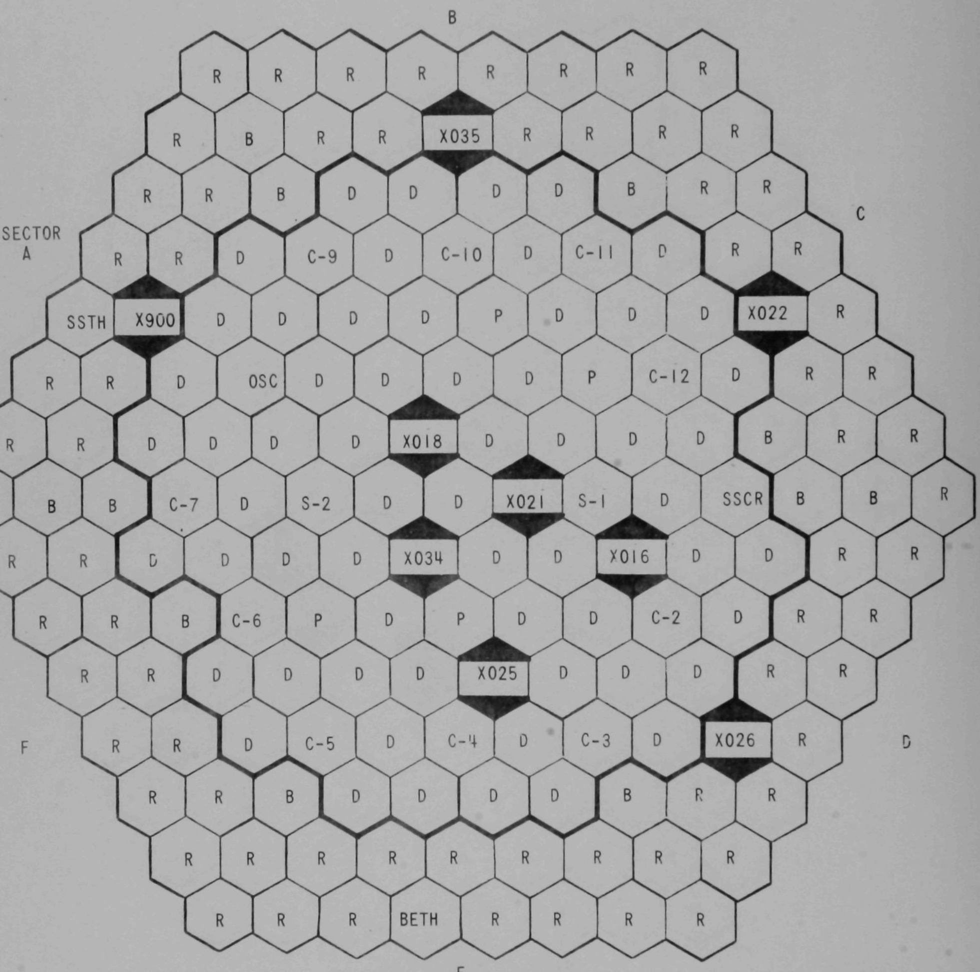


FIGURE 76
EBR-II LOADING PATTERN

RUN 27 (H) FROM 4-25-68 TO 5-2-68

KEY: SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE
SSCR - SST CONTROL ROD

C# - CONTROL ROD
S# - SAFETY ROD
D - DRIVER FUEL
P - $\frac{1}{2}$ DRIVER FUEL, $\frac{1}{2}$ SST
B - DEPLETED URANIUM
R - SST REFLECTOR

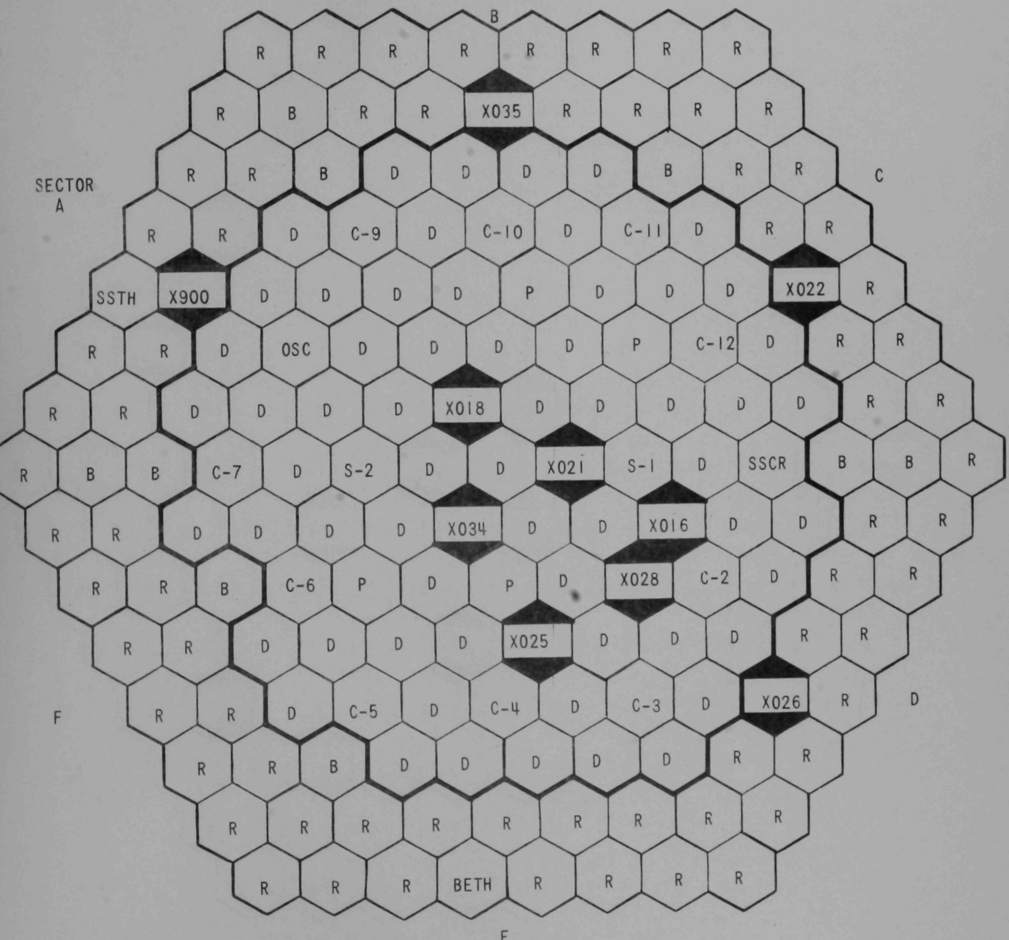


FIGURE 77
EBR-II LOADING PATTERN
RUN 27 (I) FROM 5-3-68 TO 5-6-68

KEY: SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE
SSCR - SST CONTROL ROD

C# - CONTROL ROD
S# - SAFETY ROD
D - DRIVER FUEL
P - $\frac{1}{2}$ DRIVER FUEL, $\frac{1}{2}$ SST
B - DEPLETED URANIUM
R - SST REFLECTOR

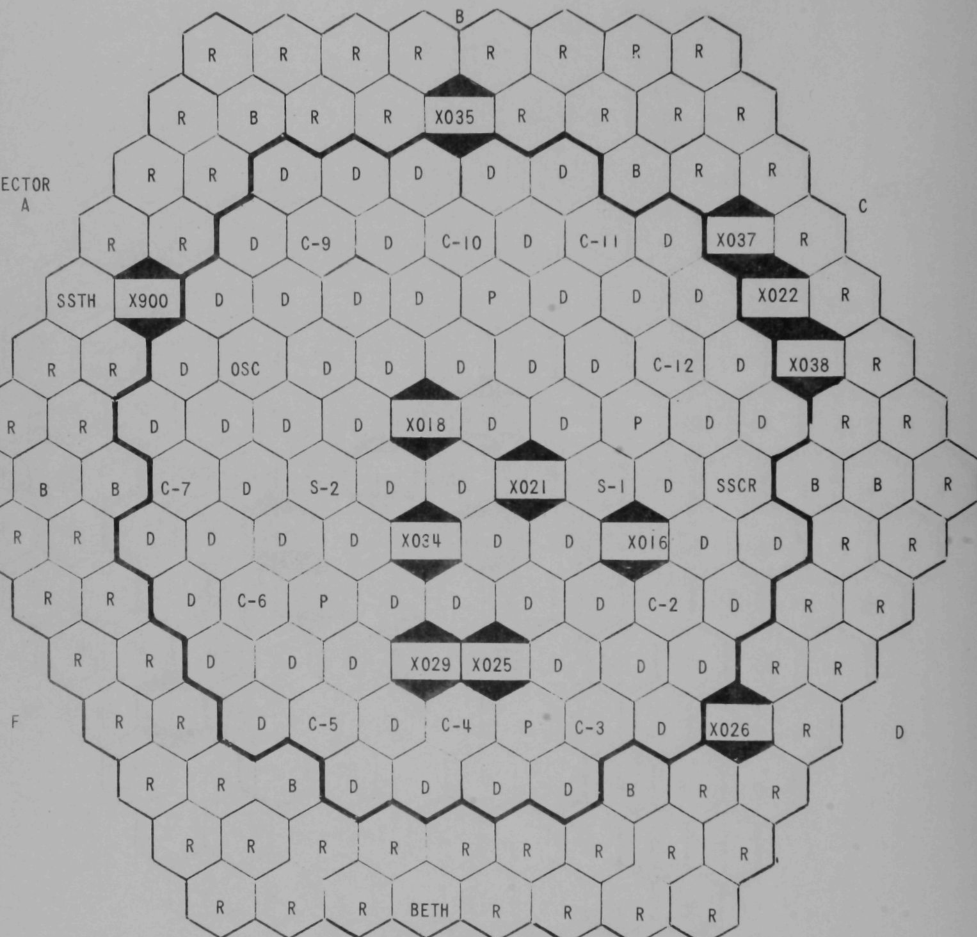


FIGURE 78
EBR-II LOADING PATTERN

RUN 28(A) FROM 5-9-68 TO 5-13-68

KEY: SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE
SSCR - SST CONTROL ROD
C# - CONTROL ROD
S# - SAFETY ROD
D - DRIVER FUEL
P - ½ DRIVER FUEL, ½ SST
B - DEPLETED URANIUM
R - SST REFLECTOR

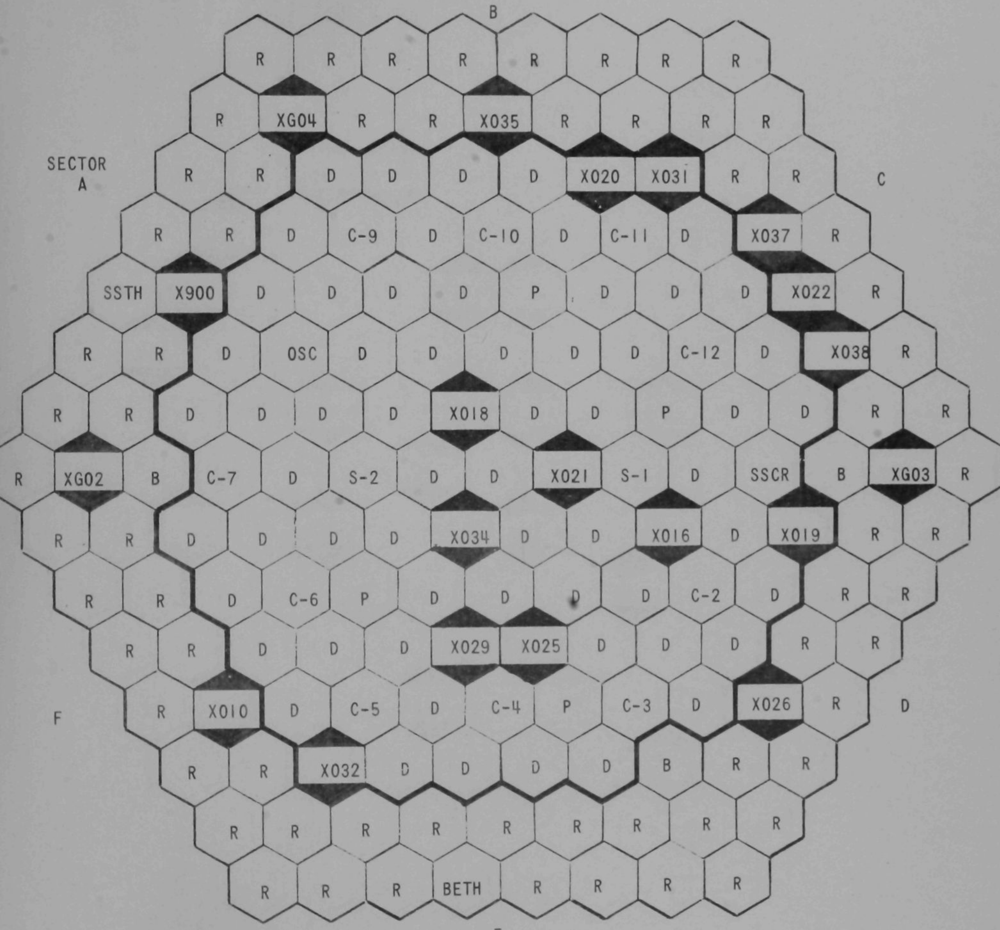
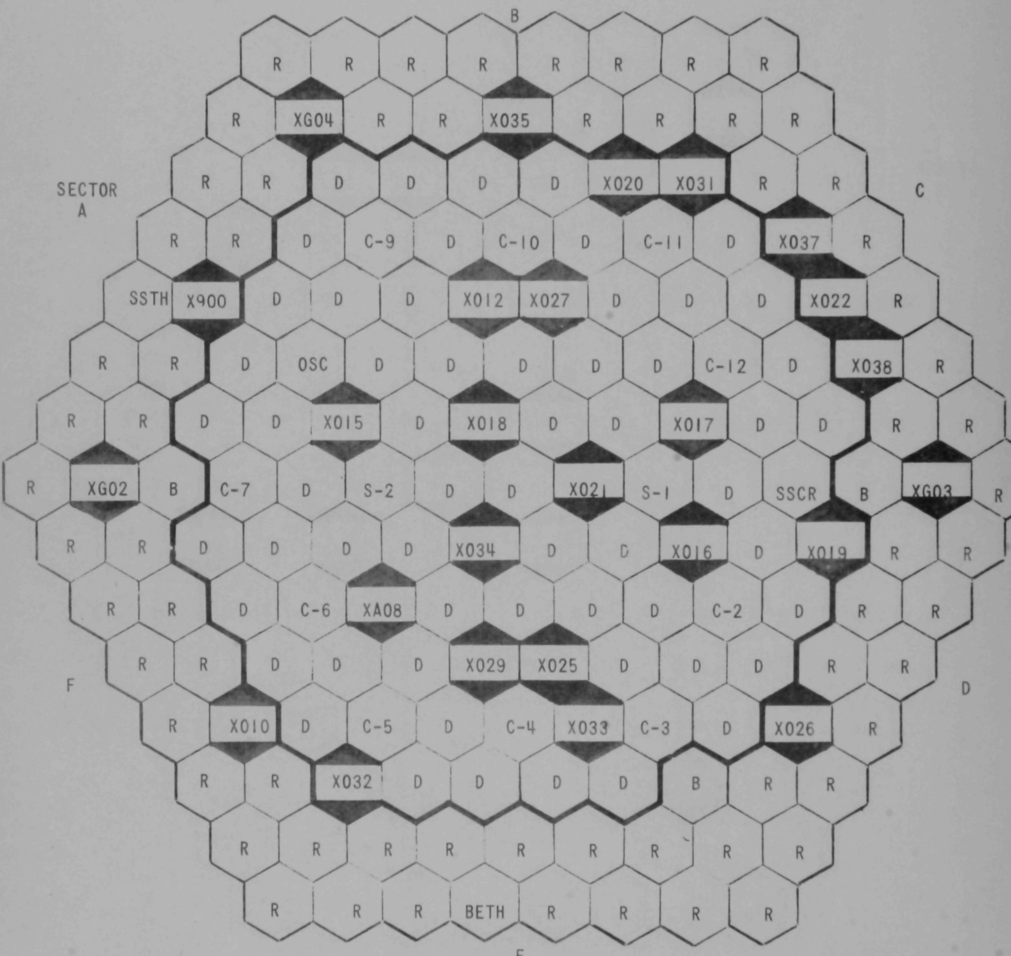


FIGURE 79
EBR-II LOADING PATTERN

RUN 28 (B) FROM 5-15-68 TO 5-27-68

KEY: SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE

C# - CONTROL ROD
S# - SAFETY ROD
D - DRIVER FUEL
P - $\frac{1}{2}$ DRIVER FUEL, $\frac{1}{2}$ SST
B - DEPLETED URANIUM
R - SST REFLECTOR



EBR-II LOADING PATTERN

RUN 28(C) FROM 5-29-68 TO 6-15-68

FIGURE 80

KEY:
SSTH - SST THIMBLE
OSC - OSCILLATOR ROD
BETH - BERYLLIUM THIMBLE
SSCR - SST CONTROL ROD
C* - CONTROL ROD
S* - SAFETY ROD
D - DRIVER FUEL
P - $\frac{1}{2}$ DRIVER FUEL. $\frac{1}{2}$ SST
B - DEPLETED URANIUM
R - SST REFLECTOR

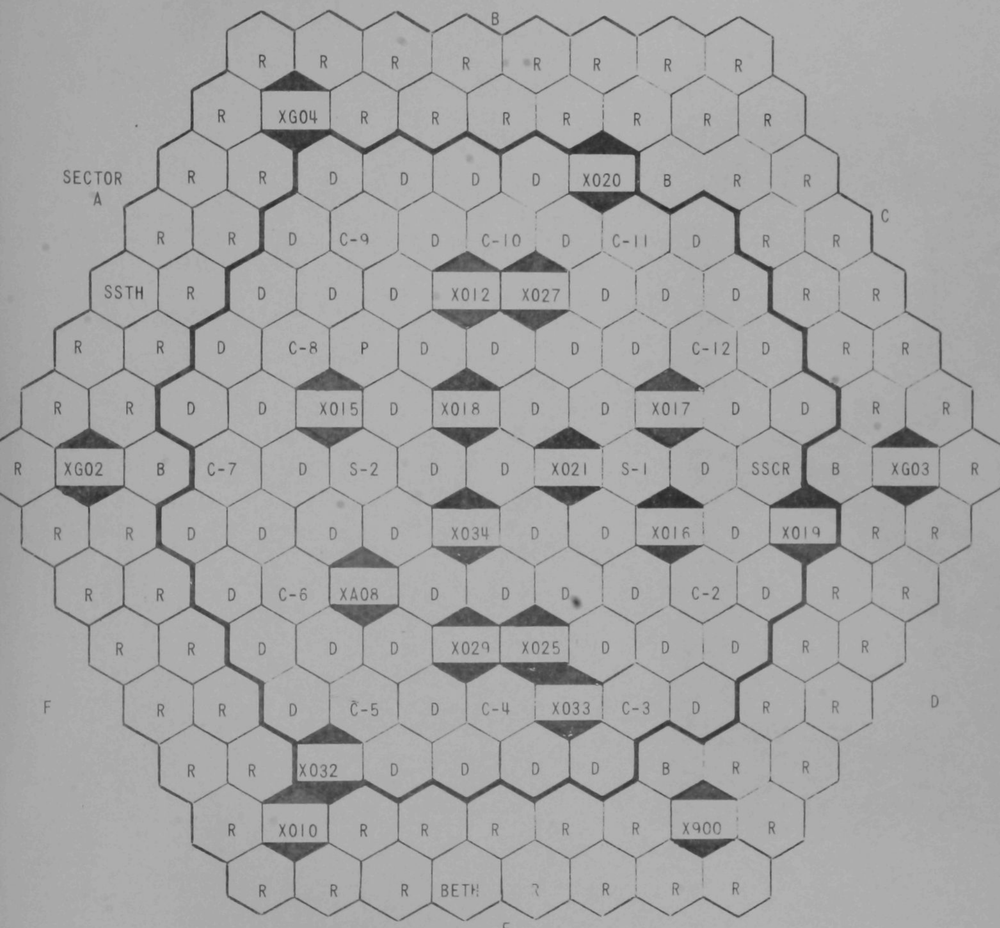


FIGURE 81
EBR-II LOADING PATTERN

RUN 29 (A) FROM 6-26-68 TO 7-5-68